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NEW YORK, AUGUST, 1887.

So much has been written about the use of torpedoes as weapons both of attack and defense in naval warfare, and so much reliance is placed on them for coast defense, that very few people realize the fact that experience with them in actual service has been very small. Since the torpedo has been fully developed there has been no great naval war, and in the very few cases where they have apparently been of service, it has been the fear of torpedoes, rather than the torpedoes themselves, which have been effectual.

For this reason a great deal of interest has attached to the remarkable series of experiments which the English Navy has been making with torpedoes in attacking an iron-clad vessel. In this case the assailants were really given every possible advantage; they were working against an old ship, not under steam, not manned while the attack lasted, and placed there simply for the purpose of being destroyed. And yet, with all these advantages, they failed to make any impression; and finally only destroyed the vessel by carefully and deliberately fastening a torpedo under the bottom of the ship and then exploding it—a proceeding which would, of course, be impossible in warfare.

The indication of these experiments is that something more effective than has yet been devised will be needed to attack a war-vessel provided with the proper means of defense; and those means are neither very elaborate nor very hard to handle.

AN article which will be read with interest, on another page gives an account of English experience with underground telegraph wires, written by an engineer who has had an extended experience in that direction. His testimony is, that the simplest means used there have been found the best in almost every respect, and the problem of burying the wires, which has been made to appear so difficult in New York, is really a comparatively easy one. In London, nearly all the over-head wires of the telegraph have been dispensed with as a matter of convenience, and new subways are put down with very little more labor than is required to lay an ordinary drain or small sewer. And in London the conditions are quite as unfavorable for such work as in New York.

The statistics of track-laying collected by the Chicago *Railway Age* show that in the first half of 1887 there were 3,754 miles of new road added to the railroad system of the United States. By far the greater part of this new mileage is in the far West and the Southwest, Kansas, Texas, Nebraska, Dakota, California and the Indian Territory leading in the list. The Eastern States show only a very small mileage.

Much of the new Western mileage is to develop and serve new country, but a large part of it is in the nature of parallel road, intended to divide business and add to the territory of rival systems. The increasing tendency to this sort of work is to be regretted.

The *Age* estimates that the total track-laying for the year will not be less than 10,000 miles. Considering the number of long lines in progress, and the fact that work began late, this seems to be a very conservative estimate.

AT the closing exercises of the Baltimore & Ohio Railroad Technological School, Professor Johnson said:

Theory is simply law deduced from a number of practical experiments applied to a new case. In illustration, the best form for side-rods of locomotives might be determined practically or theoretically. By the first means one form of rod would be used, when it broke another form would be tried, and so on until after perhaps many costly accidents the proper form might be found, which on the other hand might have been previously calculated.

There are probably a number of locomotive superintendents who would be very much obliged to Professor Johnson if he would explain how, by calculation, they can know whether their coupling rods are strong enough.

THE old idea of utilizing the great water-power of the Niagara River is revived in a new form at Buffalo, where it is proposed to raise by subscription $100,000, to be offered as a reward for the best plans for using the water-power, and for transmitting the power to Buffalo for use in the factories of that city.

If the money be secured—and it seems probable that it will be—there will be no lack of plans offered to secure the reward, and the persons who are to make the decision will have no easy task. A much better way to apply the money would be to employ one or two competent engineers of good standing to prepare plans and estimates for the work.

THE London *Engineer*, speaking of the proposed Russian oil-pipe line from Baku to a port on the Black Sea calls it "a novel engineering work," and says: "It is yet an engineering question to be solved whether the transmission through the great length of pipe designed can be accomplished in a practically commercial manner."

Apparently the *Engineer* has never heard of the use of pipe lines in this country for transporting oil, or, at any rate, does not know how extensive the pipe system here is, or to what an extent it has taken the oil business away from the railroads. This ignorance of foreign practice is truly British, however, and highly characteristic.

FEW persons except those directly interested realize the extent and value of the Lake Superior commerce, and the number and size of the vessels engaged in it. During the navigation season of 1886 the total tonnage passed through the Sault Ste. Marie Canal, which is the connecting link between Lakes Superior and Huron, was 4,528,000, only about one-fifth less than the tonnage of the Suez Canal. New locks were provided in 1882 to accommodate the growing traffic, but their capacity is already fully taxed, and further enlargement is needed. Work has been begun on a new lock, but it will take several years to build it.

A convention of delegates interested in lake commerce was recently held to advocate further improvements, including the hastening of work on the new locks and the deepening of the channel of the St. Mary's River below the falls and the entrance to the canal. This last improvement is rendered necessary by the increased size of the vessels used in the lake trade. Congress last winter made the first appropriations both for the lock and channel, and the object of the convention was to secure the appropriation of the whole amount required as soon as possible, in order that there may be no delay in the work.

SHIPBUILDING is unusually active in the yards around the lakes, as might be expected after two seasons in which lake vessels have been very profitable to their owners. At Cleveland, Bay City, Detroit and Buffalo there are a number of large vessels building, and new contracts are heard of everywhere.

Several causes have combined to bring about the prosperity which followed a long period of depression, and which has resulted in the present activity in building. The maintenance of rates by the railroad lines at a higher point than had prevailed for several years had a considerable effect; the growth of grain shipments from Duluth, due to the increased settlement and cultivation of the country tributary to that port, and the enormous increase in the Lake Superior iron ore shipments also contributed. The result was that, instead of a competition for business so sharp that it was impossible to keep rates on a paying basis, there was a demand for vessels which could not be filled fast enough.

Of course, there is a possibility that the building of new vessels may be overdone, and that the result may be such a surplus of tonnage as has existed on the ocean for several years past, as shipowners know. At present, however, that point does not seem to have been reached, and there is, apparently, room for all the new vessels.

WITHIN a few years there has been a great change in the character of vessels used on the great lakes. The wooden sailing vessels which formerly did nearly all the business have been gradually supplanted by iron steamers and barges with great capacity for freight. The steamer is the more costly vessel to build and run, it is true, but the difference is more than made up by its greater carrying capacity, its greater speed, the certainty and regularity with which its trips can be made, and its ability to dispense with the costly services of steam-tugs at various points.

The use of the triple-expansion engine and high steam pressure have greatly helped the change by reducing the weight of, and the space required for, the engines, boilers and supply of fuel. The modern engine not only requires less fuel for the same power, but it takes less room and leaves more to be occupied by paying freight.

The change in the lake marine has been very similar to that which has been going on on the ocean, and from very nearly the same causes.

THE Paris Metropolitan Railroad will not be built this year, the Chamber of Deputies having failed to pass the law authorizing its construction, although the plans had been completed and every thing was in readiness. The law was defeated, we are told, by the jealousy of the country members, and their reluctance to appropriate money for the benefit of the capital, although the Parisian deputies were all in favor of it—which reads somewhat like an extract from New York legislative proceedings.

CAR-HEATING in Massachusetts has been placed under the control of the Railroad Commission by a law which forbids the use of any pattern of heater which has not been approved by the Commissioners. In this case the Legislature has acted wisely, for the past history of the Commission is a guarantee that the discretion which the law allows it will be exercised with care and discrimination.

SOME trouble has been caused on the *Atlanta*, it is said, by the defects in the carriages on which the heavy guns are mounted. No particulars have been made public, but it would seem that the provision made for taking up the recoil is not sufficient, and that the reaction on the ship itself has been too great. A Board of Officers is to consider what should be done to remedy these defects. The *Atlanta* is the first of the new cruisers to go into commission, and it is to be regretted that there should be trouble at the start; probably the matter can be remedied without serious difficulty.

OIL FOR FUEL.

THE use of oil as fuel has been very attractive to a class of inventors who shun exact scientific knowledge, apparently for fear that it may prejudice their minds and disincline them from entertaining some of the brilliant ideas which they are pleased to contribute for the advancement of mankind. Other persons, who are not inventors, often ask the question why petroleum can not be used successfully as fuel, especially for locomotives. It has not been easy to satisfy these two classes of people that, ordinarily, you can buy more heat for a dollar if you buy coal than if you buy oil. It is, therefore, gratifying to be able to refer to reliable experiments which have been made to show the relative economy of oil and coal as fuel. Such a series of experiments have recently been made on the Pennsylvania Railroad, and they show very clearly the conditions under which oil may be used as fuel.

By way of explanation, it should be said that Mr. Thomas Urquhart, a Scotchman by birth, and who has for some years been Locomotive Superintendent of the Grazi-Tsaritzin Railway in Southeastern Russia, where there is little other fuel excepting oil, and what there is is dear, whereas oil is plentiful and cheap, has developed the first successful scheme of using petroleum as fuel—at least, in locomotives. Last year, while a representative of the Pennsylvania Railroad was in Europe, he received instructions to go to Russia and learn all he could of Mr. Urquhart's system of burning oil. On the

return of the representative who was sent there, the Pennsylvania Railroad Company determined to apply the Urquhart system to a locomotive. This has been done, and careful experiments have been made with it since.

The plan, as applied here, is shown by figs. 1 and 2. Fig. 1 is a longitudinal section of the fire-box of the locomotive As shown in the engraving, a fire-brick wall, *W*, is built up at the front end of the fire-box, with sides, *S*, and an arch, *R*, on top. The arrangement of the ash-pan is shown clearly in the engraving. The oil is fed into the fire-box by means of a form of injector shown at A, in fig. 1. The one used in the Pennsylvania experiment is a

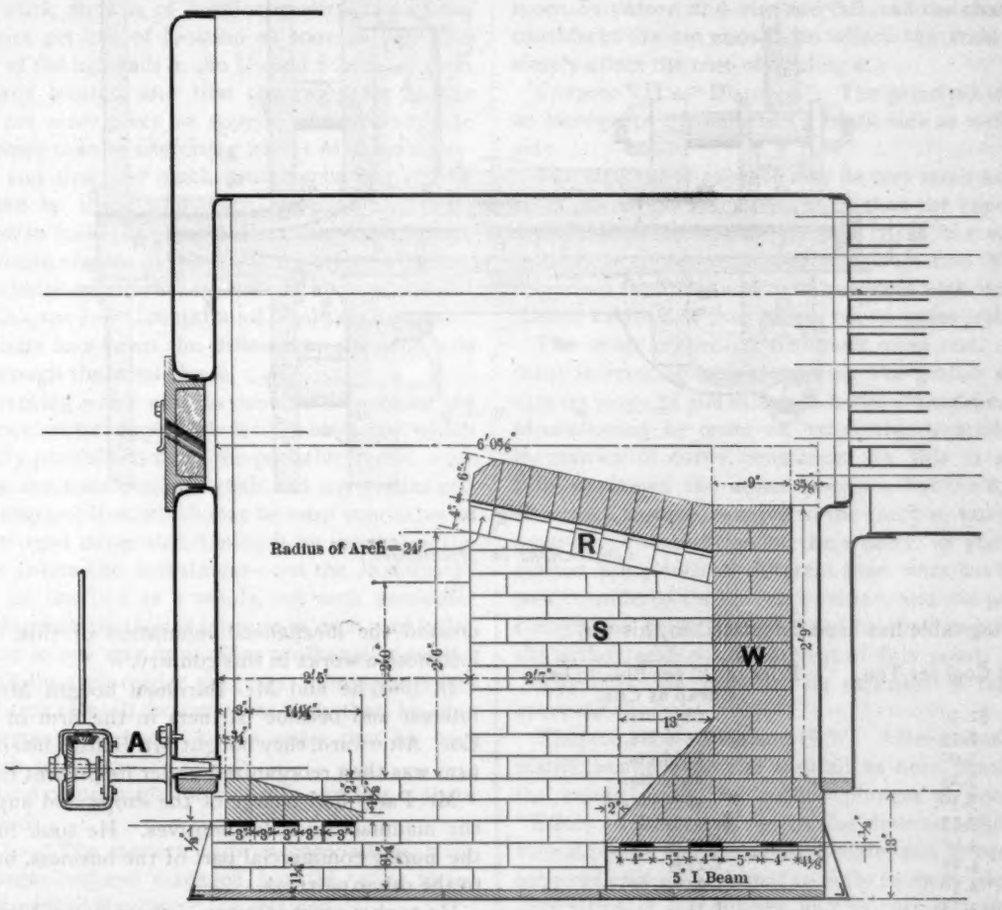


Fig. 1.

modification of that shown in section, on an enlarged scale, in fig. 2, which is copied from the drawing of that used by Mr. Urquhart. It consists of a central tube, *T*, to which steam is admitted by a pipe, shown by dotted lines at *B*. The steam enters the annular recess *c c*, and from it, through the holes *d d* passes into the tube *T*. Oil is supplied through the pipe A. When the tube *T*, is withdrawn, by the mechanism shown, it leaves an annular space around it at *e e*, through which the oil is drawn by the action of the current of steam in *T*.

The nozzle *H* of the injector or burner is inserted into a hollow stay-bolt, *K*, in the back end of the fire-box. At *g g* there is an annular opening around the nozzle of the injector. The current of steam and oil which escapes at *H* draws in a supply of air through the opening *g g*. The oil is thus converted into a finely divided spray, which is mixed with the air that enters at *g g*.

The object of the fire-brick is to receive the particles of oil that are not consumed when they are first injected into the fire-box. The shape of the fire-brick structure is that of a bonnet, with its opening turned toward the injector. It thus acts as a combustion chamber, which becomes heated to a very high temperature, and radiates heat to all parts of the fire-box, and also re-ignites the oil after it has been shut off.

In applying this apparatus to an American locomotive, considerable modification was required to adapt it for use here. The difficulties which were encountered have apparently all been overcome, and the engine to which it has been applied has now been in successful use for some time.

Of its working, it may be said that its fuel is smokeless and cinderless. The firing consists simply in the manipulation of a hand wheel, which regulates the supply of oil.

On the Grazi-Tsaritzin Railway, there are now 143 locomotives burning petroleum with the apparatus described. This fact and the experiments on the Pennsylvania Railroad show that the practical difficulties of burning petroleum have been overcome. The only question which remains is that of the relative economy of oil and coal.

Carefully made experiments and the chemical compo-

sition of both coal and oil show that the heat-producing power of a pound of petroleum is equal to that of 1¾ pounds of coal. If the saving due to the cost of handling fuel and ashes, and the diminished repairs to the fire-boxes of locomotives, is taken into account, it is found that *one pound of oil is equal in value to two pounds of coal.* A gallon of oil weighs 7.3 pounds, and a barrel contains 42 gallons. From these data it is easy to calculate the prices at which coal and oil are equally cheap.

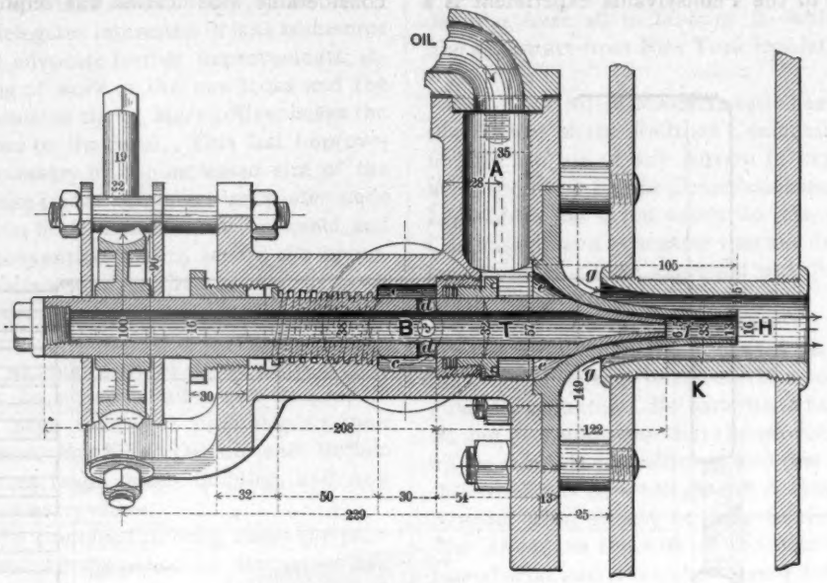


Fig. 2.

(*Dimensions in Millimeters.*)

The following table has been calculated in this way:

Price of Coal per Ton.	Price of Oil per Bbl., to be as Cheap as Coal.
$2.50	68½ cts.
2.75	75½ cts.
3.00	82½ cts.
3.25	89½ cts.
3.50	96½ cts.
3.75	$1.03½
4.00	1.10½
4.25	1.17½
4.50	1.24½
4.75	1.31
5.00	1.38

This showing does not look very promising for the general use of petroleum for fuel in this country, as any considerable demand from this source would undoubtedly put the price up, unless the production is largely increased over what it is now.

Charles T. Parry.

MR. PARRY, whose death occurred at Beach Haven, New Jersey, on July 18, was the next to the oldest member of the firm of Burnham, Parry, Williams & Co., the proprietors of the Baldwin Locomotive Works. He was born in the City of Philadelphia, on September 15, 1821, and was therefore nearly 66 years old at the time of his death. He was taken sick last November, and since then has been a great sufferer from the disease from which he died. This was an abscess in the region of the spine.

In 1836, he entered the Baldwin Works as an apprentice in the pattern shop. After serving his time, he worked as a journeyman for some years, and then went into the drawing room. In 1854, he was appointed Superintendent of the works, and he at once began to organize the system of doing work which has made this establishment famous the world over. He remained in the service of this company until his death, and he, more than anyone else, created the mechanical reputation of this, the largest locomotive works in this country.

In 1867, he and Mr. Burnham bought Mr. Baldwin's interest and became partners in the firm of M. Baird & Co. Afterward, they bought Mr. Baird's interest, and the firm was then reorganized under its present name.

Mr. Parry had charge of the shops, and superintended the manufacture of locomotives. He took little part in the purely commercial part of the business, but left that to the other partners.

He took a great interest in those under him, and was a remarkably good judge of men. He had traveled frequently in Europe and was a close observer of what he saw there and elsewhere. A widow, son and two daughters survive him. He shared in the success of the works with which he was connected and has left a large estate.

NEW PUBLICATIONS.

THE ECONOMIC THEORY OF THE LOCATION OF RAILWAYS. *An Analysis of the Conditions Controlling the Laying out of Railways to Effect the most Judicious Expenditures of Capital:* By Arthur Mellen Wellington. (New York; John Wiley & Son and *Engineering News*, 1887).

This is a "revised and enlarged" edition of the author's former book, with the same title, published ten years ago. The extent of the enlargement and revision, is indicated

by the fact that the new edition contains 980 pages, instead of 230 in the old, although larger type in the new edition must account for part of the difference in the size of the two volumes.

The title of the book has been frequently criticised. Evidently it is not the theory which is economic but the location, so that The Theory of the Economic Location of Railways would have been better.

The introduction to the book is to some extent similar to that of the first edition. The main idea of the author is that, owing to a mistaken policy on the part of the railroad companies, the location of railroads is made secondary in importance to the construction; the salaries paid to locating engineers are relatively small, and consequently the class of work done is of inferior quality, as all first-class engineers get out of location as soon as possible; the majority of the railroads in the United States are most uneconomically located, and that the engineers of the present day are more given to copying the errors of the earlier engineers than to exercising habits of close observation, etc.; and that too much prominence is given by engineers, and by those who teach them to the petty details of how to build the separate structures which make a railroad, to the neglect of the larger questions of where and when to build or whether to build at all.

Part I. Chapter I.—"Inception of Railway Projects." The author here lays down the following rule, which is his guide through the whole book.

"That excepting when and as specific reasons to the contrary appear, the cheapest line is to be built over which it is physically possible to carry the probable traffic with proper safety and speed, using to this end any grades and curves and length of line, which may be most conducive to this end only—and never abandoning it by increasing the expenditure, unless the investment—not the investment as a whole, for the line as a whole, but each particular investment for each particular purpose at each particular point—will be in one way or another profitable in itself." It will be well for each reader to get a thorough understanding of this rule—if he can—not only that he may better understand the book, but in order that he may apply the rule to his work.

The question of probable future profit and loss is there fully discussed.

Chapter II.—"The modern railway corporation, what it is, how organized and managed, both as to its financial and commercial standing," is explained.

Chapter III.—"Causes Modifying the Volume of revenue."

This is devoted principally to the effect upon traffic that the station facilities have.

The distance of the station from the business center of towns. It is well shown with what ease the future of a railroad company may be ruined by a false economy, in placing the station at some distance from the business center, and how vastly this danger is increased, where competitive lines are possible as they are in most cases. Many examples are given of the large sums of money which have been economically spent in effecting convenient station facilities for both the shipper and railroad company, by the leading roads in our large cities.

Chapter IV is devoted to the probable amount of future traffic, and contains some most instructive tables as to the growth of railway business in the past in different countries.

Chapter V.—"Operating Expenses." The operating expenses are carefully separated from the other expenses, and then examined with great care and detail. Valuable tables are given of the actual expenses of different railways. The basis of all the calculations is the *Train Mile*. The operating expenses are assumed to be per train mile, which is very near the actual fact, and then upon this basis we have Table 80, page 179, which gives the actual expense on the per cent. of each item of the operating expenses.

Part II. Chapter VI.—"The Relative Importance of Minor Details of Alignment." Making clear the distinction between the minor details and those of more importance. These minor details are divided into distance, curvature and rise and fall, and the changes to be considered are not enough to affect the train load, but simply affect the cost of hauling it.

Chapter VII.—"Distance." The principal idea is that an increase of distance has a credit side as well as a debit side.

The increase of expense may be very small and in many cases the revenue increased more than the expense.

Chapter VIII.—"Curvature." Gives the various objections to curvature, among them objection No. 8. "It impresses the imagination of travelers with danger even if none exists, and thus affects travel unfavorably."

The other objections are much more real. There are many interesting tables, showing the grades and curvature on many of the railroads in the United States, which are followed by quite an exhaustive treatise upon the mechanics of curve resistance. In this is shown and fully explained the actual position that the four wheels of a truck assume, relative to the track in passing round a curve. This position of the wheels, as shown by the author, being entirely different from what has been in the past considered the correct position, and the proofs of its correctness being the results of original experiments by the author, adds to the interest of this point.

The effect of curvature on expenses is taken up in every detail.

Chapter IX.—"Rise and Fall." After making clear the distinction between rise and fall as here considered and the ruling grade, the author plunges at once into the "Effect of Velocity," as to the difference between the virtual profile and the actual profile, and he certainly has acquired enough personal velocity to carry him over the difficulties of the subject, and as this is a subject upon which very little has been written, and the great value of which very few engineers appreciate, it will well repay the most careful study.

Part III. Chapter X.—Explains clearly the relative importance of minor and ruling grades.

Chapters XI and XII are devoted to the locomotive engine and rolling stock. The great value of these chapters is not so much perhaps in the text as in the numerous and valuable tables of reference, which cannot be found in any other one book.

Both subjects, however, are presented in a more elaborate manner, than in any existing work on railway location.

Chapters XIII, XIV and XV treat respectively of train resistance, the effect of grades upon train loads, and train loads upon operating expenses.

All these subjects are taken up in much detail.

Chapter XVI.—"Assistant Engines." This subject is handled in a masterly manner, and, together with the

chapter of the "Effect of Velocity and Momentum on Grades," presents more original ideas than any other part of the book.

They are subjects of which the generality of engineers know very little and give very little thought, and a thorough study of these chapters will undoubtedly do more to modify future grade lines and lessen operating expenses than all the other chapters of this book.

Chapter XVII.—"The Balance of Grades for Unequal Traffic" presents very little that is new except some tables.

Chapters XVIII and XIX are devoted to "Limiting Curvature" and the "Effects of Sharp Curvature."

Chapter XX, to the "Projection of Low Grades and Pusher Grades" and the "Reduction of the rate and cost of High Grades." In the case of the example of the reduction of the rate of high grades, of the location of the Pacific Branch of the Mexican Central Railway from Lepic to San Blas, there was a second location made through the Barranca Blanca the year following the location made by the author, the plan of which is given on pages 676 and 677. The last location left Lepic, and, following the general line of the highway to Fortuna and from there to near the south end of the Barranca, it entered the Barranca with a small cut, crossed it on a pile of moderate height, turned to the north, and following this side of the Barranca, joined the old line at the point where it (the old line) ran out of the Barranca.

This new line had about 800 degrees less of curvature than the old line, had no higher rate of grade, and was about 3 kilometers (1.8 miles) shorter. The cost of construction on the whole line was very much less, and it did away with the high trestle and spirals.

The fourth reason given for the first location, page 678, is "a dull, uninteresting ride would have been substituted for one of the greatest scenic attractions. A chief dependence for the traffic of the Pacific Branch (and for the main line of the Mexican Central Railway as well) being tourist traffic, and much of the remainder of the line being of great scenic beauty, this alone was deemed a decisive consideration," is directly contradicted by the author in his objections to curvature number 8, page 243; also, the "moral effect" of the shorter line is in its favor.

The traffic of the Hacienda de la Escondida, and that due to the water-power of the River Lepic, would not, by any means, have been lost, but would have come to the railway. The difference in scenic effect is very little, as the only view of any grandeur is obtained just where the line enters the Barranca, and was as fine from one line as the other.

Part IV. Chapter XXVI.—"Trunk Lines and Branches." This treats principally of the increment of traffic due to increasing of the number of traffic points reached, and which of these points should be reached by the main line and which by branch lines.

Chapter XXII.—"Light Rails and Light Railways." Treats principally of the false economy in buying light rails. That the amount of money saved in using light rails in the place of heavy ones goes a very little way toward construction, while the loss to the railroad company by the use of the light rails is tremendous in every way.

That the true place to save money on a light railroad is in the fitting the line to the ground by the use of sharp curves and steeper grades, and not by cutting down the rail section.

Chapter XXIII.—"Economy of Construction." Treats of the many expedients which can be used in the construction when extreme economy is necessary, in order that, when it is desirable to raise the road to first-class, very little of the original cost will have to be wasted, and that the location will be everything that it should be.

Chapter XXIV.—"Improvement of Old Lines and the Virtual Profile." As this subject is becoming of more importance every day, and as this is the most elaborate treatise on it.

Chapters XXV and XXVI.—"Grade Crossings and Interlocking and Terminals." These subjects also becoming daily of more importance, increase the value of the treatment they here receive. There are also some valuable tables concerning some terminals as they actually exist.

Part V.—"Conduct of Location." This commences with the art of reconnoissance, which is justly claimed to be by far the most important part of location. "The worst errors of location generally originate in the reconnoissance." With proper attention to the rules set forth, and close study in each particular case, there should generally exist no necessity for running but on general line. This line, of course, must be fitted in detail to the ground.

The remainder of the book is taken up with hints and rules for engineers on actual location.

The subject is taken up with so much detail, that scarcely a question can arise of which the answer cannot be found in this Part V. It is particularly good in the instruction given in regard to maps and topography.

Appendix A is a well-written description of some experiments of the resistance of rolling stock conducted by the author.

Appendix B is a description of a series of experiments, and their results, with a new apparatus on journal friction at low velocities by the author.

Appendix C. A paper on "the American line from Vera Cruz to the City of Mexico, with notes on best methods of surmounting high elevations by rail, including plan and profile of the line."

And last but not least is an elaborate index, by means of which the book, as a reference, is vastly increased in value.

Taking the book as a whole, no book that has yet been written on the same subject can in any way compare with it.

As a text-book, or a book for students, it should be used with great care. But there is this great thing in its favor, that if any one doubts the correctness of the conclusions and rules, as stated by the author, he has only to take the same data which the author used, and which is all given in the book, and work out his results to suit himself.

BOOKS RECEIVED.

THE GRAPHICAL STATICS OF MECHANISM: BY PROFESSOR GUSTAV HERRMANN; TRANSLATED AND ANNOTATED BY A. P. SMITH, M.E. New York; D. Van Nostrand, 23 Murray street.

CINCINNATI BRASS WORKS CATALOGUE: 1887. Cincinnati, Ohio; F. Lunkenheimer, Proprietor.

SCIENCE. New York; the Science Company. This very excellent and valuable weekly begins its fifth year by adopting a new form and reducing its subscription price to $3.50 yearly. In its new form the page is about the same size as that of the JOURNAL. The quantity of reading matter is the same as in the old form, with the smaller page. Our contemporary will, we hope, secure the increase in circulation which it deserves.

PRINTING MACHINERY: BY EDWARD ARNOTT CLOWES. London, England; published by the Institution of Civil Engineers.

THE TREATMENT OF GUN STEEL: BY COLONEL EARDLY MAITLAND, R. A. London, England; published by the Institution of Civil Engineers.

THE MAVERICK NATIONAL BANK MANUAL: 1887. Boston; published by the Maverick National Bank. This is a manual of Government, State and other securities, issued for the use of investors and giving much useful information.

LIGHT, HEAT AND POWER. Philadelphia, No. 413 Walnut Street. With the issue of July 1 this journal changes from a monthly to a semi-monthly, published on the 1st and 15th of each month.

THE FRACTURE OF RAILWAY TIRES: by WILLIAM WORBY BEAUMONT. London, England; issued by the institution of Civil Engineers.

EXPLORATIONS ON THE WEST COAST OF FLORIDA AND THE OKEECHOBEE WILDERNESS: BY PROFESSOR ANGELO HEILPRIN. Philadelphia; published by the Wagner Free Institution of Science. This is Volume 1 of the *Transactions* of the Wagner Institute, and forms a valuable contribution to the geological and zoological knowledge of a region heretofore little known.

MECHANICAL DEFECTS OF OUR RAILROADS: BY CHARLES W. FELT. Northboro, Mass. Mr. Felt proposes a very startling change in our railroad system, and engineers will read his pamphlet with curiosity, if not with approval.

THE FISHKILL CORLISS ENGINE. Fishkill-on-Hudson, N. Y.; issued by the Fishkill Landing Machine Company. This is a very neat and complete catalogue of the engines, boilers and machinery made by the well-known shops of the company whose name is on the title-page.

THE DURHAM SYSTEM OF SCREW-JOINT IRON HOUSE DRAINAGE. New York; issued by the Durham House Drainage Company.

OBITUARY.

JAMES S. MCENTEE, an old civil engineer, died at his home in Rondout, N. Y., June 30, aged 87 years. He served as Assistant Engineer on the Erie Canal and on the Union Canal in Pennsylvania. Later he was employed on railroad work, both as engineer and contractor, and built sections of the Hudson River road. He made the surveys and located the Rondout & Oswego (now the Ulster & Delaware) road. He retired from business some years ago.

Mr. J. BRUEN MILLER, who died at Newton, N. J., July 3, aged 29 years, was a young man of much promise, and his early death from consumption will be mourned by many friends. He was a resident of Newark, N. J., and for a number of years had been engaged in newspaper work. He was connected with the AMERICAN RAILROAD JOURNAL as editor for about three years, and left it in July, 1886, on account of ill-health.

CAPTAIN SAMUEL P. GRIFFIN, formerly of the United States Navy, died at Aspinwall (Isthmus of Panama), July 4, aged 60 years. He graduated from the Naval Academy in 1841 and served through the Mexican war. In 1849 he commanded the brig *Rescue*, which took part in the Arctic expedition of that year. During the last war he served in Louisiana. For some 20 years past he has been in the service of the Pacific Mail Steamship Company. He was a high authority on navigation and shipbuilding, and his opinion was sought for by many shipowners.

PROVANCE MCCORMACK, who, with James Campbell, in 1841 established the first coke oven and made the first coke in this country, died June 21, at Connellsville, Pa., aged 88 years. He was a grandson of Colonel William Crawford, the first settler in that part of Pennsylvania. Mr. McCormack made a large fortune in various business enterprises, but the great failure of B. F. Bear, a few years ago, ruined him, and when he died he was dependent for a living on the small fees derived from his office of Justice of the Peace.

CHIEF ENGINEER HENRY LEE SNYDER, United States Navy, died in Washington, June 30, aged 50 years. He was born in Pottstown, Pa., and entered the Navy when 21 years old. He rose gradually to the rank of Chief Engineer and stood high on the list of officers of that rank. For several years past he has been detailed as Superintendent of the State, War and Navy Department Building in Washington.

M. M. GREENE died in Columbus, O., June 26, after a short illness; he was 57 years old. He was born in Vermont, and, after serving on the Vermont Central road, went into business as a contractor. In 1867, he was appointed Vice-President and Chief Engineer of the Columbus & Hocking Valley Railroad. In 1874, he became President of the company and retained that office when the present Columbus, Hocking Valley & Toledo Company was formed by consolidation. In 1881, he resigned on account of ill health and retired from business.

O. B. FILLEY, a prominent figure in the industrial community of St. Louis, died at Richfield Springs, N. Y., whither he had gone in quest of better health. Mr. Filley was 51 years of age and had for 25 years past been identified with the iron industries of St. Louis. He was for many years Secretary of the Fulton Foundry Company, and at the time of his death was President of the Missouri Furnace Company, a director in the Joliet Steel Company, the St. Louis Malleable Iron Company and Third National Bank, besides being a large stockholder in the Granite Mountain Mining Company. Mr. Filley was personally popular among the iron men.

WILLIAM WALLACE, who died in Buffalo, N. Y., June 20, aged 82 years, was born in Scotland and came to the United States in 1832. He was an engineer and surveyor by profession and was employed in the building of the old Attica & Buffalo road, and was Superintendent of that line for some years after its completion in 1842. He was Chief Engineer of the Attica & Hornellsville line and afterward of the Buffalo & State Line road. He was the first projector of the line which was afterward built as the Buffalo, New York & Philadelphia and made the original surveys for that road. He retired from business several years ago on account of increasing age.

CHRISTIAN E. DETMOLD died at his home in New York, July 2. He was born in 1809 in Hanover, where he was educated at a military school. He came to this country in 1835, and adopted the profession of a civil engineer and contracter. He built the old Charleston & Hamburg Railroad in South Carolina, one of the first railroads in the country, and later was engaged in constructing canals in Maryland and Pennsylvania. He also built the Crystal Palace in New York in 1853. He was for many years the owner of a large coal mine in Pennsylvania, and in this business amassed a large fortune. Between 1842 and 1850 he gave much attention to the introduction into this country of Faber du Faur's method of utilizing furnace gases in heating the blast. About 15 years ago Mr. Detmold went to Paris, where he lived until within a few years. He married Miss Phœbe Crary and had two daughters, both of whom are married. His wife and daughters survive him.

JACKSON BAILEY died at his residence in Brooklyn, N. Y., July 7, aged 40 years. He was born in Schenectady, N. Y., served in the army when still a boy, and afterwards graduated from the State Normal School at Albany, N. Y. After teaching for several years, he connected himself with a New York publishing firm for a short time, and then became Eastern representative of the *American Manufacturer*, of Pittsburgh.

In November, 1877, he joined Horace B. Miller, under the firm name of Miller & Bailey, in establishing the *American Machinist*. The paper was successful from the start, and Mr. Bailey retained his connection with it up to the time of his death, though his failing health during the past two years had, during a considerable portion of that time, rendered him unable to do active work. His disease was of malarial origin and developed into consumption of the bowels. He leaves a widow, but no children.

At the time of his death Mr. Bailey was First Vice-President of the New York Press Club and a member of a number of engineering societies. He was one of the founders of the American Society of Mechanical Engineers. He was a quiet, unassuming man, but won the esteeem and confidence of those who knew him by his uprightness and the thoroughness of his work.

COLONEL A. A. TALMAGE, General Manager of the Wabash, St. Louis & Pacific lines, died June 28, at Peru, Ind., while on his way from St. Louis to Toledo in his private car. He had suffered from chronic diarrhœa for several months. He was born in Warren County, N. Y., in 1834, and received a substantial elementary education. When had reached the age of 15 he became a clerk in a general merchandise store at Goshen, Orange County, N. Y., where he remained two years. At the age of 18 he was employed in the freight department of the Erie Railroad, and soon attracted attention by his quick apprehension of economical methods of despatching railroad business. In 1858, he went to Chicago in the interests of the Michigan Southern Railroad. He was placed in charge of the business of that company at Monroe, Mich., and subsequently at Toledo, O. When Mr. Talmage was about 25 years old he became a passenger conductor on the railroad. In 1864, he was appointed Assistant Superintendent of the line from East St. Louis to Terre Haute. He resigned this charge in October of the same year on receiving the appointment of Master of Transportation for all the railroads under Government control south of Chattanooga. He was very soon made Superintendent of the same lines, and remained in that important position till the military power turned over the lines to the companies after the close of the war. For some time thereafter he was General Superintendent of the East Tennessee & Georgia Railroad.

In 1868, when the St. Louis, Alton & Terre Haute Railroad had been leased by the Indianapolis & St. Louis Company, he resumed the duties from which he had resigned in October, 1864. In October, 1870, he was appointed General Superintendent of the road. In March, 1871, he was appointed General Superintendent of what was then known as the Atlantic & Pacific Railroad. In December of the same year the general superintendence of the Missouri Pacific Railroad was intrusted to him, and for a period of years he remained in active charge of that very important system. He was the originator of a plan for railroad hospitals to be supported by an assessment on the wages of the employés. When the Wabash passed under Missouri Pacific control it was placed under Colonel Talmage's charge, and when the lines were separated again he remained with the Wabash, and continued to manage its lines Colonel Talmage was considered a manager of great ability.

ALFRED KRUPP, the distinguished metallurgist and manufacturer, died at his home in Essen, Prussia, July 14, aged 75 years. The great steel works at Essen were founded by Friedrich Krupp in 1810 as a small forge, employing only two workmen, and continued to grow under his management until the date of his death, in 1826, when Alfred Krupp, his son, was only 14 years old. From 1826 to 1848 the works were carried on by the widow and sons in company, Alfred displaying a phenomenal aptitude for the business and remarkable executive ability. In 1848, Alfred Krupp, whose death is now annonnced, took entire charge of the works, and carried on the business under the firm name of Friedrich Krupp, and to him is due the credit for the establishment of these, the most extensive, and in some respects the finest works in the world.

The discovery which had most effect upon them, was that of a way to cast steel in large masses, an unsurmountable task prior to Krupp's experiments. He signalized his discovery by sending to the London Exhibition of 1851 a block weighing 45 German quintals, which at that time was a great curiosity. General attention was then called to the works and their business rapidly increased. Herr Krupp was among the first to adopt the Bessemer process, and rapidly extended its use. Guns, armor-plates, rails, tires, and many other articles of Krupp make are to be found in all parts of the world.

Engineers are chiefly interested in the many improvements introduced by Herr Krupp in the treatment of iron and steel. His were among the very earliest works to adopt any new process which promised well, and several dephosphorizing processes have long been used there. As, however, his works were very jealously closed against visitors, and a secret was made of nearly every thing about them, only general information was allowed to get into print. It is charged that, while Herr Krupp was prompt in adopting every improvement in iron and steel making, he rarely gave credit or reward to the inventor whose improvement he adopted.

The enormous extent of the Essen Works may be appreciated from the following interesting figures with regard to the growth of the establishment which were published in 1884. In 1860 Essen Foundry had only 1,746 workmen, but that number had risen to 7,084 ten years later, and it was in 1884 upward of 20,000. Counting the women and children, Herr Krupp's establishment gave employment in 1884 to 65,381 people, of whom 29,000 lived in houses belonging to their employer. The foundry was divided into eight sections, and there were 11 blast-furnaces, 1,542 other furnaces, 439 steam-boilers, 82 steam-hammers, and 450 steam engines representing 185,000 horse-power. At Essen alone, to say nothing of the branch establishments, there were nearly 40 miles of rails, 28 locomotives, 883 trucks, 369 horses, 191 wagons, 40 miles of telegraph wires, 35 telegraph stations, and 55 Morse instruments. Since then large additions have been made to the works.

Herr Krupp was a model employer; he built excellent houses for his officers and men, hospitals for the sick, established sick, burial and pension funds for his employés, and generally took the warmest interest in their welfare.

The importance of his services and his wealth induced Emperor William to offer him letters of nobility in 1864. They were, however, declined.

Contributions.

THE GEODETIC WORK IN THE UNITED STATES.

VI. THE U. S. COAST AND GEODETIC SURVEY.—CONTINUED.

BY PROF. J. HOWARD GORE.

IN the subsequent operations of the Survey, so many skilled observers and able computers have been employed that it is well-nigh impossible to specify to what extent the success is due to them, or how much praise the following superintendents deserve. In this article only a concise statement will be made to show how the methods have been improved, what accuracy has been attained and the amount of work that has been performed.

The primary triangulation, which Hassler's successors have regarded as the mainstay in their plan of procedure, has been so far extended as long ago to suggest its utilization as data in the great geodetic problem. When the importance of this subsidiary feature came to be fully considered, no intelligent person could be found to say that undue refinement had been practiced. Francoeur, in speaking of the methods proposed at the beginning, said: "They prove the work of a very learned and well-exercised engineer, who knows perfectly all the geodetical methods and the methods of observation, who knows their difficulties and defects, and has diminished the causes of error and given to the results all the precision possible."

During the field season of 1844 two bases were measured, one along the Boston & Providence Railroad, in the immediate vicinity of the site Borden had selected for the measurement of his base of verification; this base, nearly 11 miles long, was very rapidly measured, with Hassler's apparatus, on a graded and unobstructed side track. The other was the Kent Island base, on which a modified form of Hassler's apparatus was employed.

The unfavorable conditions for triangulation existing along the coast of the Southern States necessitated more numerous bases, and with this increase in number it was deemed advisable to so simplify the apparatus as to diminish the cost of the work. While this was being done, it was desired to introduce other advantages, such as: That the length of the apparatus be invariable at different temperatures; that the bars have equal absorbent powers for heat; that they be supported so as to be stiffened laterally as well as horizontally, while capable of free motion; that they be enclosed in a way which prevents sudden changes of temperature, the covering also giving stiffness; that the whole be supported at two points only, and easily movable in the different directions required for adjustment in measurement. The general conditions to be fulfilled and a description of the apparatus were given to Mr. Würdeman, the Mechanician of the Survey—his name still being attached to the results of his ingenious skill.

Professor Bache had determined, by a long series of very careful experiments, the relative cross-sections of the bars of iron and brass, which were to constitute a new base apparatus for the use of the Survey, depending upon their difference of specific heat and conducting power, the absorbent qualities of their surfaces being adjusted by the use of different colored varnishes.

This apparatus consists of an iron and a brass bar, firmly united at one end, the brass bar being placed on the lower side. At the opposite end a short lever of compensation is jointed to the brass bar, its polished steel surface being pressed against the end of the iron bar by a spring, which is so attached to a small rod placed parallel to and above the iron bar, that it constantly acts to draw the rod back and the end of the compensating lever with it. The arms of the lever are proportioned to each other as the expansion of iron to brass, or as 1,100 is to 1,748, or very nearly as the expansion given by Smeaton of iron, 0.001258, and by Laplace of brass, 0.00186671.

The lever being proportioned as above stated, when the brass and iron bars are expanded by heat its outer end will not be moved, but will keep exactly its normal distance from the opposite end of the apparatus, where the two bars are fixed together. The expansion of the short iron rod on the end of the lever is allowed for in the arrangement, and it carries on its end a polished agate plate, ¼ in. in diameter, which is the surface of contact at that end of the apparatus. At the other end (where the bars are fastened together) there is a Bessel contact level, with an iron rod acting upon it. By means of a spring, this iron rod is thrust outward, so that, in making contact, the knife-edged agate in which it terminates is brought against the agate plane on the opposite or lever end of another bar of exactly the same size and construction. The bar is then moved gently until the contact level shows a horizontal position, when the distance between the agate surfaces at the fixed and lever ends is the normal length.

This apparatus was first used on the Dauphin Island base, measured in 1847. Here the probable error was found to be about two-hundredths of an inch in a mile; the length had been obtained by comparing six single meters, placed end to end with the apparatus as a whole, while the individual meters were compared with an authentic standard meter—one of those originally made by the French Committee on Weights and Measures. It was brought to this country by Mr. Hassler, and presented by him to the American Philosophical Society.

The comparisons of length were made by means of Saxton's pyrometer, a very simple instrument, but one affording the highest degree of accuracy: "A small mirror, movable about a vertical axis, reflects into the field of a telescope, placed at a distance of 20 ft., the divisions of a long curved scale placed under the telescope; by means of a small abutting piece attached to the mirror, any difference in length to be measured causes a corresponding rotation of the mirror, by which different scale-divisions appear on the wires in the telescope, and a greatly magnified indication is thus obtained by an index equal in length to twice the distance of the mirror from the scale. The quantity is thus readily magnified 2,000 times, without any loss from inertia and flexure, which would be unavoidable in obtaining a similar result by means of mechanical levers."

Ascertaining in this way the exact length of the apparatus, a principal source of error in obtaining the length of the base is eliminated, leaving only errors such as arise from uncertainties in determining the coefficients of the component bars, and adjusting the lever of compensation in the ratio of these coefficients, together with errors that arise in manipulating the apparatus. These

admit of computation, and the sum total of their effect given as the probable error. The following table gives the principal items of interest connected with the measurements of all the bases with the Bache-Würdeman apparatus:

Name of Base.	When measured	Length in miles.	Number of tubes.	Hours employed	Probable error.
Dauphin Island.....	1847	6.66	1777	143	1:410000
Bodie's "	1848	6.75	1807	81	1:425500
Edisto "	1850	6.66	1787	97	1:418600
Key Biscayne.....	1853	3.6	965	67	1:454400
Cape Sable.....	1855	4	1702	46	1:551600
Epping Plains.....	1857	5.4	1453	67	1:551600
Peach Tree Ridge....	1872	5.8	1556	84	1:561880

In 1880 it was decided to construct a new apparatus, which would be simpler in construction, but would secure all the advantages found in the Bache-Würdeman. First of all, it was decided to have the length five meters, instead of six. The measuring-bar is composed of two metals, so proportioned as to be compensating for changes of temperature, and rigidly connected, but without any points, levers or movable parts, which not only complicate the construction, but also introduce sources of error in the unequal wear of the different parts. In this form there is a large bar of zinc, and fastened near each end is a steel bar, extending in a direction towards the opposite end, thus forming three parallel bars, on the gridiron principle. The expansion or contraction of the zinc bar is exactly counteracted by the expansion or contraction of the two steel bars, but since the coefficient of expansion of zinc is about 2¾ times that of steel, the zinc bar is necessarily the shorter. In order to secure the bars against the differential expansion that might arise from incorrect proportionment of the size and length of the component bars, the zinc bar is allowed to project beyond the points of attachment, where, in connection with the accompanying steel bar, a Borda scale is applied. Mercurial thermometers were also provided. The "Mudge" contact-slide was employed, instead of the complex contact-level. The only base measured with this apparatus was the Yolo base, in California.

In this instance, the bars during measurement were protected from the action of the sun by an awning made of sailcloth, placed on wheels, so that it could be moved as the work progressed. Twenty-four men were employed 408 hours in the actual measuring of 8,494 bars, which represented two entire measurements and a segment of somewhat more than the entire line. The length obtained is 17,486.51193 meters, with a probable error, equivalent to $\frac{1}{1881800}$ of the length. In this apparatus, authenticated temperature changes were not always accompanied by corresponding indications of the Borda scale. In short, the behavior of the zinc component was so unsatisfactory that a new apparatus is under consideration, in which the scale readings will be omitted, and either a partly compensated pair of bars or a single, carefullly protected bar of steel adopted instead, with very frequent comparisons with a field standard.

The triangulation of the Geodetic Survey is in keeping with the base determination. It is divided into primary and secondary, the difference being based upon the length of sides rather than difference of precision. The angles are measured with great care, the maximum error allowed is 0".3, while the average falls below 0".15, and in Nevada and California it is still less. An idea of the accuracy of pointing and reading can best be formed when it is stated that the greatest error made in determining the position of a signal is less than the radius of the object observed. The average error in closing a triangle has varied between 0".25 and 1".25, irrespective of size.

Great improvements have been made in theodolites; hard metal has taken the place of soft metal, and they are constructed with stronger frames than formerly. The optical power of the telescope is increased and the focal distance diminished, the former in conformity with the increase in precision of the graduation, which also allows a general diminution in size of other parts of the instrument, the former large circles of 30 miles diameter having given way to those of 20, used at present. The illumination of the field of the micrometer is radial, and the microscopes are rendered more efficient by aplanatic lenses, giving better definition and greater magnifying power. The complex repeating-circles and verniers have passed out of date for all larger instruments. The spokes of the graduated circles have disappeared, and full, thin plates have taken their place, clamps are attached to the axis, and the circle may be shifted in various positions with the greatest ease.

The test of accuracy of both base measurements and triangulation is the difference found in the length of a junction line depending on two primary bases connected by intervening triangulation.

In this connection may be cited the comparison of the Epping, Massachusetts and Fire Island bases: Their distances apart are:

Epping to Massachusetts	295 miles.
Massachusetts to Fire Island	430 "
Epping to Fire Island (direct)	430 "
Epping base measured	8715.962 M.
Derived from Mass	8715.865 "
" " Fire Island	8715.900 "
Massachusetts base measured	17326.376 "
Derived from Epping	17326.528 "
" " Fire Island	17326.445 "
Fire Island base measured	14058.971 "
Derived from Epping	14059.039 "
" " Mass	14058.916 "

Again: Kent Island and the Atlanta bases are separated by 602 miles; from each the common line, Buffalo to Moore, about 29½ miles in length, was computed, giving a difference of only 16 min., or six-tenths of an inch. The difference between the lengths of this line before final adjustment was less than 3 inches.

In the astronomic determination, similar success has been achieved, owing both to the instruments used and the methods of reduction. The results for latitude have gained much in precision by the introduction of more precise star-places (in declination), which has become possible by the introduction of new catalogues and by the recent labors of astronomers, particularly Boss and Auwen, in submitting the catalogued places to systematic discussion. In the telegraphic instruments, short and split electro-magnets, possessing the property of rapid charge and discharge, have been introduced, along with improved chronographs, of great regularity of motion and instantly changeable to double speed when required for exchanges.

This is what the Survey has accomplished: Fifteen bases have been measured, with the success already mentioned; nearly eleven thousand primary stations have

been occupied; the coast triangulation and hydrography extended from Maine to Mexico, with a few breaks; the coast of California, with short stretches in Oregon and Washington Territory, along many navigable rivers, and nearly four-fifths of the transcontinental chain extending along the 39th parallel.

This stupendous work has been oriented by 188 stations for azimuth, and put in its correct place on the spheroid of latitude observations at 300 stations, and longitude at 115, while magnetic observations have been made at nearly 700 places, and gravity experiments made at numerous stations, not only in this country, but also in various parts of the world.

The reductions have also received attention, equally with the field work. To all observations a criterion is applied, and those used are properly weighted. The most advantageous figures are used in first adjustments, and when the triangulation has progressed sufficiently to include another base, the whole is subjected to the rigorous conditions that the co-ordinates of the termini should be the same from direct observation and computation, and that the lengths of all lines be the same when computed from both bases.

In longitude computations, particular attention is paid to the relative weights depending upon: The stars' position, the value of the time determination, the variations in personal equation, and the performance of the chronometers with respect to time elapsed between time determination and the exchange—arbitrary signals being used, instead of automatic.

For its publications, this institution deserves our sincerest thanks; in the annual reports, beginning in 1854 as separate volumes, are to be fonnd thorough discussions of every branch of Geodesy; among them are 22 papers on base-measuring and 25 on field-work and reduction of the triangulation.

If the Geodesists of the world were asked to lay out the future work of the Survey, they would suggest the filling up of that small gap, which, with the excellent work of the Lake Survey, and the Surveys of New York and Pennsylvania, would give a meridional arc or of 8° and of supreme importance they would consider the continuance of the transcontinental belt along the 39th parallel, giving an arc of 46° perpendicular to the meridian. Then, with the adaptability of this country for an arc of a meridian of 16°, we would not be satisfied until its length and amplitude were determined, as well as the lines of level to connect the Atlantic with the Pacific, and the Great Lakes with the Gulf of Mexico.

QUADRUPLE-EXPANSION MARINE ENGINE.

THE quadruple-expansion engines shown in the accompanying illustrations were recently built by Rankin & Blackmore, of Greenock, Scotland, for the *Myrtle*, a vessel used for summer excursion business. The boat is 163 ft. long, 20 ft. 6 in. beam and 14 ft. moulded depth, her registered size being 318 tons. The engines shown were put in to replace an old compound engine of the ordinary type. On the trial trip the *Myrtle* made 12 knots an hour, with a consumption of 1.2 lbs. good Welsh coal per H. P. during a run of three hours.

For the illustrations and the following description we are indebted to *Engineering*:

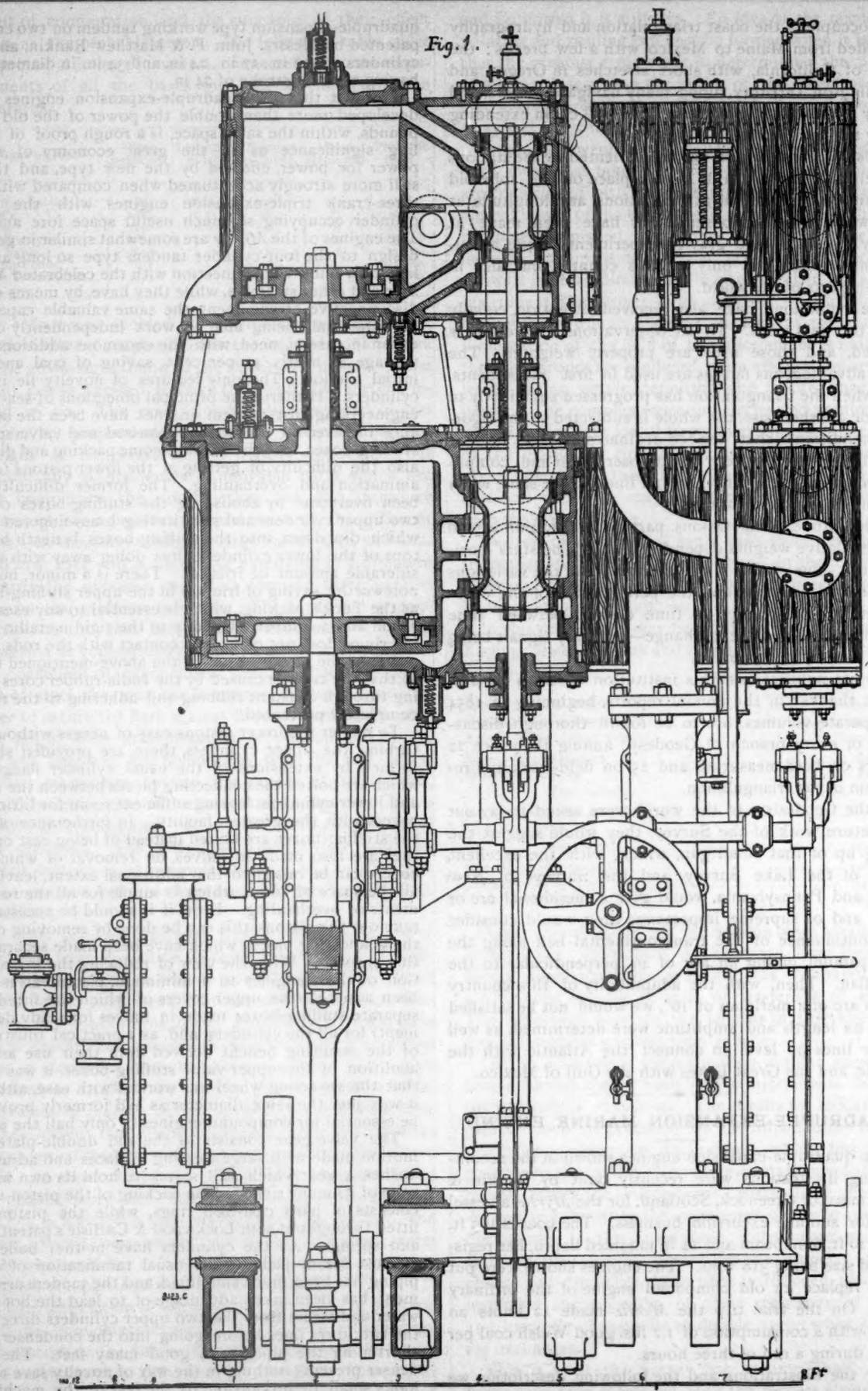
The new engines are of the four-cylinder, disconnected, quadruple-expansion type working tandem on two cranks, patented by Messrs. John F. & Matthew Rankin, and the cylinders are 12 in., 17 in., 24 in. and 34 in. in diameter, all having a piston-stroke of 24 in.

The fact that the quadruple-expansion engines have developed more than double the power of the old compounds, within the same space, is a rough proof of startling significance as to the great economy of room, power for power, effected by the new type, and this is still more strongly accentuated when compared with the three-crank triple-expansion engines with the third cylinder occupying so much useful space fore and aft. The engines of the *Myrtle* are somewhat similar in general design to the four-cylinder tandem type so long and so favorably known in connection with the celebrated White Star and other steamers, while they have, by means of the disconnective arrangement, the same valuable capability of either half being able to work independently of the other in case of need, with the enormous additional advantage of nearly 40 per cent. saving of coal and less initial friction. The only features of novelty lie in the cylinders. Hitherto the principal objections of sea-going engineers against tandem engines have been the annoyance involved in the extra piston-rod and valve-spindle stuffing-boxes, with their troublesome packing and glands; also the difficulty of getting at the lower pistons for examination and overhauling. The former difficulty has been overcome by abolishing the stuffing-boxes on the two upper cylinders and substituting brass-fingered tubes which dip down into the stuffing-boxes beneath on the tops of the lower cylinders, thus doing away with a considerable amount of friction. There is a minor, but still noteworthy, saving of friction in the upper stuffing-boxes, as the Tuck's packing, which is essential to any escape of steam and to impart elasticity to the rigid metallic packing rings, does not come into contact with the rods at all, owing to the interposition of the above-mentioned tubes, so that the trouble caused by the India-rubber cores melting through constant rubbing and adhering to the rods is completely prevented.

To render the lower pistons easy of access without disturbing the upper cylinders, there are provided shelves formed by extensions of the usual cylinder flanges, to which are bolted the connecting pieces between the upper and lower cylinders, leaving sufficient room for lifting the covers with the greatest facility. In furtherance of this, the stuffing-boxes are bolted instead of being cast on, and they are also made in halves, on removal of which the covers can be raised to that additional extent, leaving in all the space of 16 in., which is ample for all the requirements of overhauling. Even if it should be necessary to take out the pistons, this can be done by removing one of the connecting pieces, which have been made separate for this purpose. With the view of reducing the initial friction of these engines to a minimum, piston valves have been adopted (the upper covers of which are fitted with separate stuffing-boxes made in halves for ready detachment) for all the cylinders, and, as a practical illustration of the resulting benefit derived from their use and the abolition of the upper valve stuffing-boxes, it was found that the reversing wheel was worked with ease, although it was just the same diameter as had formerly proved to be essential for compound engines of only half the power.

The valve-gear consists of the old double-plate link motion made with large wearing surfaces and adjustable bushes, a gear which still seems to hold its own well, in spite of its many rivals. The packing of the piston-valves consists of hard cast-iron rings, while the pistons are fitted throughout with Lockwood & Carlisle's patent rings and springs. As the cylinders have neither boiler nor exhaust steam jackets, the usual ramification of drain piping has been much simplified, and the tandem arrangement has been taken advantage of to lead the hot drain water and steam from the two upper cylinders direct into the two lower ones before going into the condenser, thus shortening the pipes by a good many feet. The condenser presents nothing in the way of novelty save that it looks small in proportion to the rest of the machinery, with its 618 sq. ft. of cooling surface, nearly 50 per cent. less than the usual practice for compound engines, thus

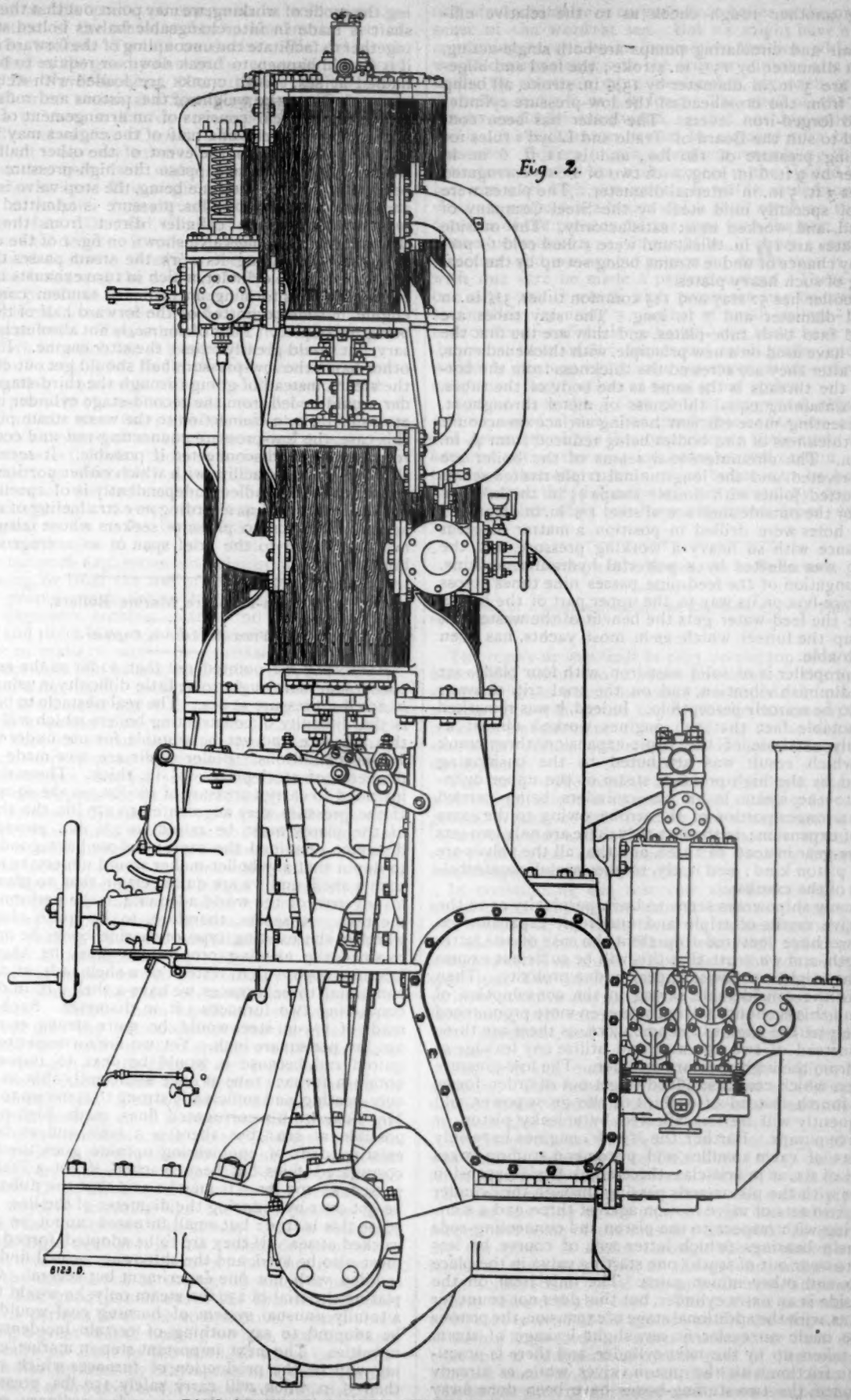
Fig. 1.



FOUR-CYLINDER TANDEM QUADRUPLE-EXPANSION ENGINE.

BUILT BY RANKIN & BLACKMORE, GREENOCK, SCOTLAND.

Fig. 2.



FOUR-CYLINDER TANDEM QUADRUPLE-EXPANSION ENGINE.

BUILT BY RANKIN & BLACKMORE, GREENOCK, SCOTLAND.

forming another rough check as to the relative efficiency.

The air and circulating pumps are both single-acting, 14 in. in diameter by 13½ in. stroke; the feed and bilge-pumps are 3 in. in diameter by 13½ in. stroke, all being worked from the crosshead of the low-pressure cylinder by solid forged-iron levers. The boiler has been constructed to suit the Board of Trade and Lloyd's rules for a working pressure of 180 lbs., and is 11 ft. 6 in. in diameter by 9 ft. 6 in. long, with two of Fox's corrugated furnaces 3 ft. 5 in. in internal diameter. The plates were made of specially mild steel by the Steel Company of Scotland, and worked most satisfactorily. The outside shell plates are $1\frac{5}{16}$ in. thick, and were rolled cold to prevent any chance of undue strains being set up by the local heating of such heavy plates.

The boiler has 52 stay and 115 common tubes, 3½ in. in internal diameter and 7 ft. long. The stay tubes are screwed into both tube-plates, and they are the first the makers have used on a new principle, with thickened ends, so that after they are screwed the thickness from the bottom of the threads is the same as the body of the tubes, thus maintaining equal thickness of metal throughout, and presenting more efficient heating surface on account of the thickness of the bodies being reduced from $\frac{5}{16}$ in. to $\frac{3}{16}$ in. The circumferential seams of the boiler are double-riveted, and the longitudinal triple-riveted seams have butted joints with double straps $\frac{7}{8}$ in. thick. The rivets for the outside shell are of steel 1¼ in. in diameter; all the holes were drilled in position, a matter of great importance with so heavy a working pressure, and the riveting was effected by a powerful hydraulic machine. A prolongation of the feed-pipe passes nine times across the smoke-box on its way to the upper part of the boiler, so that the feed-water gets the benefit of the waste heat going up the funnel, which, as in most yachts, has been made double.

The propeller is of solid cast-iron, with four blades set aft to diminish vibration, and on the trial trip this was found to be scarcely perceptible. Indeed, it was remarked as a notable fact that the engines worked almost as smoothly as those of the triple-expansion three crank type, which result was attributed to the cushioning afforded by the high-pressure steam of the upper cylinders; to the steam in all the cylinders being carried during a longer portion of the stroke, owing to the extra stage of expansion; to the fact that there are only two sets of valve-gear instead of three, and that all the valves are of the piston kind; and lastly, to the careful counterbalancing of the cranks.

As many shipowners seem to be in perplexity as to the respective merits of triple and quadruple-expansion engines, we have ventured to present the case of the latter at length, and we trust that this will be sufficient excuse for what might otherwise appear undue prolixity. Then there is the considerable saving in the consumption of coal, and this economy will become even more pronounced relatively as the engines become worn, as there are three traps instead of two to catch and utilize any leakage of steam from the high-pressure cylinder. The low-pressure cylinder, which can least afford to get out of order, forms only a fourth instead of a third of the gross power, and consequently will be less affected by a leaky piston or defective pumps. Further, the *Myrtle's* engines have only four sets of valve spindles and piston-rod stuffing-boxes instead of six, as in first-class three-crank triple-expansion engines with the piston-rods passing through the cylinder covers, two sets of valve motion against three, and a similar saving with respect to the piston and connecting-rods and main bearings (which latter will, of course, be less liable to wear out of truth), one starting valve in the place of two, and other minor gains. The only item on the other side is an extra cylinder, but this does not count for much, as, with the additional stage of expansion, the pistons may be made an easier fit, any slight leakage of steam being taken up by the next cylinder, and there is practically no friction with the piston valves, while, as already mentioned, the two stuffing-boxes have been done away with.

With regard to the disconnective gear, before explaining the mode of working, we may point out that the crank-shaft is made in interchangeable halves bolted strongly together to facilitate the uncoupling of the forward engine, if it should happen to break down, or require to be overhauled at sea. Both cranks are loaded with weights to counterbalance the weight of the pistons and rods. The disconnective gear consists of an arrangement of valves and piping, whereby one-half of the engines may be utilized without delay in the event of the other half going wrong. For instance, suppose the high-pressure half to become useless for the time being, the stop valve is closed and steam at about 60 lbs. pressure is admitted to the second intermediate cylinder direct from the boiler through the reducing valve shown on fig. 1 of the engravings, and after doing its work the steam passes through the low-pressure cylinder, which in turn exhausts into the condenser, thus forming an ordinary tandem compound engine, if time permitted of the forward half of the shaft being uncoupled. This, of course, is not absolutely necessary, but would greatly relieve the after engine. If, on the other hand, the low-pressure half should get out of order, the steam, instead of going through the third-stage cylinder, would be led from the second-stage cylinder into the atmosphere, by a connection to the waste steam pipe. In this case, the low-pressure connecting-rod and eccentric-rods should be disconnected if possible. It seems to us that the extreme facility with which either portion of the engine can be handled independently is of special value for a tourist vessel, as affording an extra feeling of security against detention to pleasure seekers whose leisure time may be limited to the brief span of an average summer holiday.

High-Pressure Marine Boilers.

(From the London *Engineer*.)

RECENTLY we pointed out that, so far as the engine is concerned, there ought to be little difficulty in using steam of 250 lbs. pressure at sea. The real obstacle to be feared is the difficulty of constructing boilers which will sustain this pressure and yet be suitable for use under the prevailing conditions. Boiler shells are now made 14 ft. in diameter, of steel plates 1½ in. thick. These shells are intended to carry a pressure of 160 lbs. on the square inch. If the pressure were augmented to 250 lbs. the thickness of the plates must be raised to 2⅜ in., provided the diameter remained the same; and we have good reason to doubt that any boiler-maker would undertake to make such a shell, and we are quite certain that no plant exists in any part of the world adequate to the performance of the task. It seems, therefore, to be quite clear that, whether the existing type of marine boiler be or be not retained, the existing proportions must be abandoned. Let us suppose that, instead of a shell 14 ft. in diameter containing three furnaces, we have a shell 9 ft. in diameter containing two furnaces 3 ft. in diameter. Such a shell made of 1½-in. steel would be quite strong enough for 250 lbs. per square inch. Yet we are no nearer to the required end, because it would be next to impossible to obtain a furnace tube at once sufficiently thin to prevent over-heating, and sufficiently strong to stand up to 250 lbs. Mr. Fox, by his corrugated flues, made high-pressures possible at sea; but there is a limit, and, so far as the existing drift of engineering opinion goes, the limit for corrugated flues has been reached, if not a little overpassed, at 160 lbs. It may be said that the difficulty can be got over by reducing the diameter of the flue. In one sense this is true; but small furnaces cannot be properly worked at sea. If they are to be adopted, forced draught must also be used, and the shipowner would find himself saddled with not one experiment but several. Contemplating the trial of 250 lbs. steam only, he would find that a totally unusual system of burning coal would have to be adopted, to say nothing of certain incidental minor novelties. The next important step in marine engineering will be the production of furnaces which, not more than ½ in. thick, will carry safely 150 lbs. pressure, and yet be quite suitable for use under ordinary sea-going conditions.

Arrived at this point, we expect to be told that the best solution of the whole difficulty lies in the use of water-tube boilers. To this we demur. We are by no means blind to the good points in, for example, the Root and the De Nayer boilers; but tubulous boilers have been well tried at sea and found wanting. The great objection to them is that for a given power they take up an inordinate amount of space. Their heating surface is inefficient. Seventy square feet of surface in an ordinary marine boiler will make more steam than 100 ft. in a tubular boiler. This ought not to be so. It is contrary to all reason. It is absurd, but though absurd it is a stubborn fact. On land, this is of no consequence; at sea, it is a vital defect. It may be obviated perhaps. Till it is we must deal with things as they are. If, then, the water-tube boiler and the ordinary boiler cannot be used with high pressures, what is to be done? Unfortunately it is much easier to criticise and condemn than it is to suggest a remedy. Two schemes may, however, be mentioned, both of which are at least worth discussion.

A shell of steel, $\frac{7}{16}$ in. thick, double riveted, will sustain a bursting pressure of about 1,100 lbs., so that with a working pressure of 250 lbs., there would be a factor of safety of a little over four, which is sufficient. A boiler might be constructed of such cylinders, fired outside, and would be perfectly safe; because it would be free from all the objctions which are justly urged against externally-fired boilers of the ordinary type. Such boilers have been used, although of very crude design, for many years on the great rivers of the United States. They have, it is quite true, exploded now and then with disastrous results; but such explosions have almost always resulted from racing, or from the use of extremely muddy water without proper precautions. In the hands of modern English engineers nothing of the kind need be apprehended, and there is enough about such a system of construction to make it worth more consideration than it has yet received. Of course, each boiler proper would be built up of a number of sections, each consisting of one tube, 3 ft. in diameter and 8 ft. or 9 ft. long, flanged and riveted to a properly stayed flat-sided chamber, which would at once put all the sections in free communication and provide a portion of the steam place. Something in this direction was done years ago by Mr. Howard, of Bedford, and the experience he acquired might be utilised to make a further advance. A very powerful argument against externally-fired tubes must not be forgotten, however. It is well known that an ordinary furnace crown may come down without any one being killed or even scalded. The overheated metal bulges and stretches, but it does not give way, and even when it does crack so as to permit the escape of large volumes of water, the steam, instead of rushing into the stokehole, finds an exit up the funnel. Unfortunately, there is reason to fear that this would not be the case if an externally-fired cylinder became overheated because of accumulated deposit or other cause. Under these conditions, the overheated plate would give way with disastrous results, unless some special, not very easily devised arrangements were made to insure the safety of the firemen and engineers.

We have said above that two methods of construction suggest themselves. One we have just considered, the other means resorting to, in a sense, the locomotive type. Now, to this, insurmountable objections have hitherto arisen, when it was tried in the merchant service, although it has been very successfully adopted in war ships by both France and Great Britain. But we do not believe that the last word, or anything like the last word, has been said about the locomotive type at sea. One of the great objections urged against it is that a small depth of water is carried over the fire-box crown; but this is not the fault of the system, but of the way in which it has been applied. The good points about the locomotive boiler are, that it permits us to use comparatively small shells containing a great deal of heating surface, and that there is practically no limit to the strength which can be imparted to flat surfaces by staying, so that, consequently, we can have a fire-box or furnace of any dimensions we deem necessary without the least apprehension of evil results. We do not for a moment contemplate the adoption of a locomotive or torpedo-boat boiler in the ordinary sense of the word at sea. But we might have a boiler containing at one end a locomotive fire-box, which box would communicate with the ordinary uptake of a marine boiler by three or more steel tubes, say each 12 in. in diameter, and 3 ft. or 4 ft. long. The shell of the boiler proper could be subdivided, so that nothing more than about 4 ft. in diameter would be exposed to a bursting pressure. Boilers in some respects resembling this type have been used at sea with success in the United States, but not with high pressures. It will be understood that what we propose is a boiler which shall combine the best features of the present marine type with the best features of the locomotive type. It would be, in short, a composite structure, and we see no reason to doubt that it might with due care be made a perfect success. There is just one other way in which high pressures may be carried at sea, namely, by using a number of small boilers—simply reduced copies of the large boiler—but, as we have shown, they must have small furnaces and small grates, and they would in the aggregate take up much more space than one or two large boilers of equal gross power.

Against everything that can be suggested, objections will be urged. But that quadruple-expansion engines and pressures of 250 lbs., or perhaps a little more, will be adopted within the next few years we feel certain, always provided that the right kind of boiler is to be had. It may be that the difficulty will be solved by departing much further than we have suggested from existing types.

Some Remarkable Breaks in a Reservoir.

[Abstract of a paper read before the Engineers' Club of Philadelphia by Mr. Lewis N. Lukens.]

THE reservoir was built in 1873 on the top of Conshohoken Hill, about 200 ft. above the level of the Schuylkill River, from which the water is pumped. In plan it is a square of 151 ft. at the top of the embankment, with a division embankment rising half way to the top of the side walls. When ordinarily full it holds about 1,000,000 gallons.

The earth of the locality is of a rather light character, with enough talc in it to make it feel rather greasy. The general rocks of the locality are limestone, and the variety quarried and sold as Conshohocken stone. The exact geological conditions of the locality I have not knowledge enough to describe.

In constructing the reservoir the banks were raised about as much above the natural level as the excavation was beneath it, the earth from the excavation being used for the embankments. These were well rolled and allowed to settle as much as possible in the course of construction. The bottom and sides were then lined with 18 in. of stiff fire-clay, put on in layers of about 3 in., each layer being well rammed. Above this there was put a brick pavement, and this was washed over with hydraulic cement.

The inlet and outlet pipes were cast-iron pipes laid in masonry. This masonry was composed of ordinary undressed stone, laid in hydraulic cement and extended out to about the middle of the embankment.

The reservoir was finished in the fall of 1873, and water was let in soon after. In December, 1873, only a few months after the water was let in, the first break occurred. This break commenced just above the outlet pipe and followed the line of the pipe through the embankment, laying bare some of the masonry described as surrounding the pipe. It broke through the embankment just about at the natural level of the ground, and was about 15 ft. across at the top of the embankment, narrowing, of course, toward the bottom. The curious part was, however, that instead of the ground below showing evidences of such a large body of water passing over it, it showed that only a comparatively small part of the water had escaped that way and covered the low land just below. The larger part of the water must have escaped by some other channel, necessarily a subterranean one. This first break was repaired by filling in with stiff fire-clay and

finishing as before. In the summer of 1876 the second break occurred. This was in the middle of the west compartment and was an absolute giving way of the bottom, there being no break in the sides. It was simply a hole of about 25 ft. in diameter and of indefinite depth. A line was let down at least 85 ft. without finding bottom, and stones thrown in seemed to rattle down indefinitely. The ledges of rock seemed to be inclined toward each other thus, V, and the slippery talcous earth had been washed from between them, nobody knows where. Whether the water from the first break started it, is of course not known, although it seems, at least, possible.

In repairing this, the crevices between the rocks were filled up and arched over with masonry, going as deep as necessary to get a solid support for the masonry, in one case as much as 34 ft. below the bottom of the basin. The hole was then filled in with stiff clay and iron ore screenings, principally clay. The top was then planked over with hemlock planks, and the clay lining rammed down and covered with brick, as before.

In the spring of 1879, three years after, the third break occurred. This was in the other compartment, taking away part of the partition wall and part of the bottom, and was a good deal like the preceding one. An interesting fact is that a well near by, 80 ft. deep, and which had had 8 or 10 ft. of water in it, was completely emptied the night the break occurred and has not held any water since. There must have been some underground channel by which the water from both found its way to the river.

This hole was filled up with masonry and clay, like the other. The clay lining was then taken off, and the whole basin, sides, bottom and partition embankment, were planked over with heavy hemlock plank. The clay was then put on again to a depth of 14 in., and the whole surface bricked as before. This time it lasted for eight years, until last fall, when a small break occurred. Some small quantity of water had washed the earth from between two rocks, in the side of and near the bottom of the end embankment, in the same old way. The weight of the superincumbent water had then sprung back the side planks, and the water had escaped by some underground channel. Being relieved of the weight, the planks had sprung back. The fact of the springing back and subsequent release is shown by there being a number of small fish caught and crushed in the cracks. This was repaired, as usual, by filling in with fire-clay, and at that particular place there is now 3 ft. of fire-clay rammed in between the rocks, then the planking, then 14 in. more clay, and then the brick lining. It is hoped now that it will last.

THE NEW NAVAL VESSELS.

THE Secretary of the Navy has approved the report of the board which examined the plans for the new warships, so far as to direct the acceptance of the plan submitted by the Barrow Shipbuilding Company, of England, for the armored battle-ship. The Navy Department purchases the design, and is at liberty to make such modifications as may be desired. As it will take some two years to make the armor-plates for this ship and the armored cruiser, some time will elapse before work on the ships themselves is begun. The vessel, which will probably be built at the Brooklyn Navy Yard, is described below:

THE ARMORED BATTLE-SHIP.

The accepted plan of the Barrow Company presents the feature of having the water line well protected by heavy armor and also the guns on the upper deck, but of leaving the intermediate space between the upper and lower decks wholly without protection, there being nothing there of importance. The buoyancy of the ship is well assured by a deflective deck at the top of the water-line armor. Some of the recently built Italian battle-ships embody this principle, which has given rise to much discussion in professional circles. There are two turrets *en echelon*—that is to say, not in the middle of the ship, but on either side of the median line, so that their guns can fire directly forward and aft or to either side.

The designer was Mr. William John, an eminent naval constructor. His object was to present a design by which good steaming and manœuvring qualities could be obtained, an abundance of coal stowed, endurance, and the comfort of officers and men. A wider range of guns, with a heavy bow and stern fire is provided. Defense against attack by torpedo boats and boarders, the distribution of the machine guns and their protection; to accomplish this is one of the salient features. Another commendable feature is the ample protection afforded all vital parts of the ship from the enemy's shot and shell, by which the stability of the vessel is insured, even though the ends of the vessel were perforated above the protected deck; and if the ends of the vessel were perforated beyond the armor belt there would still remain some protective stability.

Following are the dimensions and general description of the armored battle-ship:

	Ft.	*In.*
Length between perpendiculars	200	0
Beam, extreme	64	1
Depth molded to upper deck	39	8
Mean draught of water	22	6
Displacement at 22 feet 6 inches draught, fully equipped, with 500 tons of coal on board (tons)	6,300	
Indicated horse power, forced draught	8,600	
Indicated horse power, natural draught	5,800	
Speed at above displacement, using forced draught. (knots)	17	
Using natural draught (knots)	15½	

Battery—Two 12-in. breech-loading rifles; six 6-in. breech-loading rifles.

The secondary battery consists of 22 machine guns, so disposed as to secure a heavy bow and stern fire and a good defense against torpedo-boat attack.

The vessel will be a twin-screw double-turret ship, with an armored redoubt enclosing the lower part of the turrets, the hydraulic machinery for moving the turrets and loading the guns and the funnel casings of the boilers.

It is fitted with a ram bow, heavily strengthened, forming a powerful weapon. The hull is built entirely of steel on the cellular system, the double bottom extending throughout the machinery and magazine spaces—a length of 158 ft.

This bottom is divided into numerous water-tight compartments, as is the hull, by numerous longitudinal and athwarthship bulkheads. The protection of the vital parts of the ship consists of a steel-faced armor belt 12 in. in thickness, extending sufficiently forward and aft to embrace the engines, boilers and all magazines, terminating at each end with an armored steel-faced breastwork 6 in. thick extending diagonally across to the center of the vessel.

This armor is thoroughly backed by a system of rigid framing and girders; additional protection is furnished by a steel deck 3 in. thick, extending the whole length of the vessel, sloping from beyond the armor belt toward the bow and stern, protecting the steering gear and underwater torpedo rooms and gear.

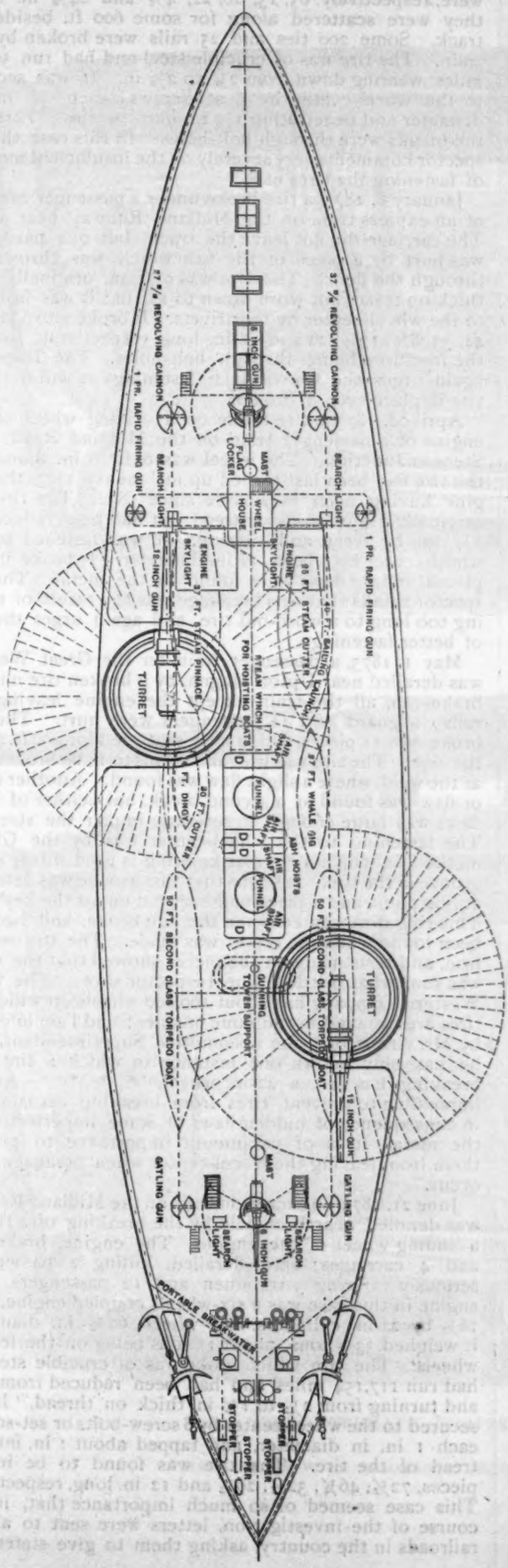
Above the protective hull are the main and spar decks, where the accommodations for the officers and crew are arranged and batteries located.

The machinery is all placed below the protective deck, the engines in two and the boilers in four water-tight compartments.

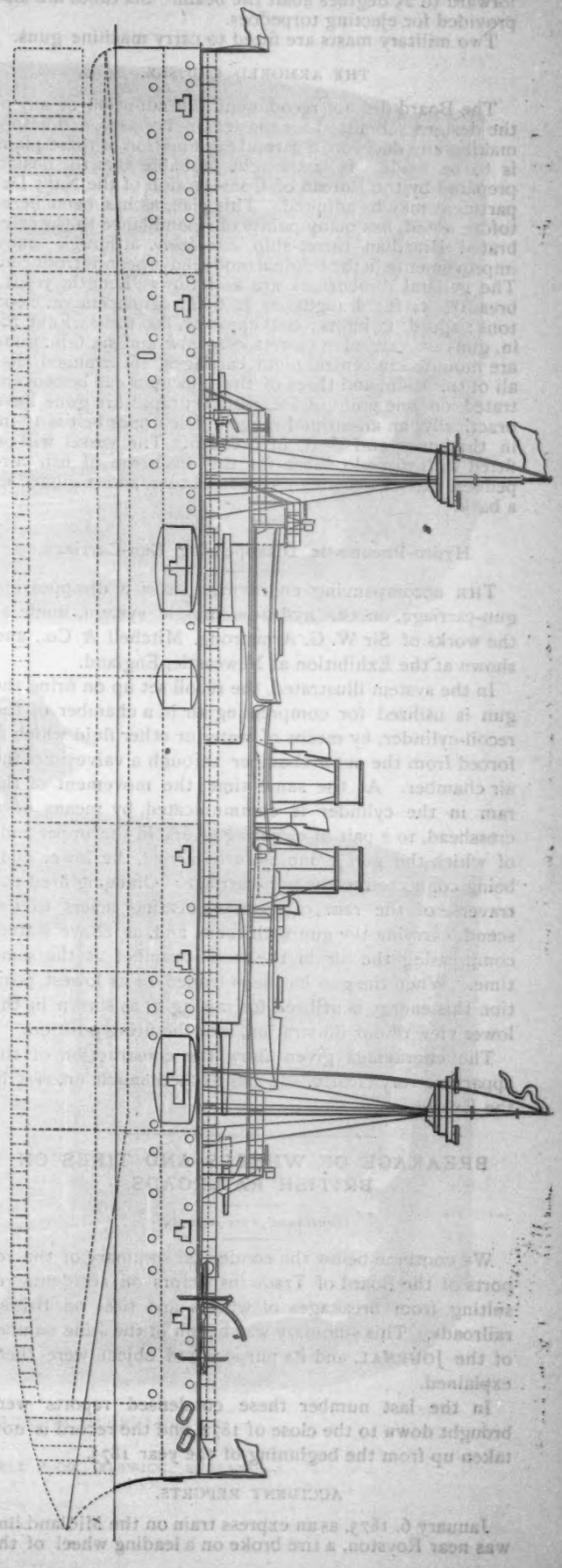
The stowage of coal is so arranged as to afford as much protection to the unarmored parts of the vessel as possible.

The two 12-in. breech-loading guns are mounted each in a turret protected by 12-in. steel-faced armor. These turrets are placed *en echelon*, so as to command a fore-and-aft fire from both. Each gun has a complete broadside range on one side, and a range on the opposite side of 40 degrees for the forward gun and 70 degrees for the after one. Two loading positions are provided for each gun. Two 6-in. guns are arranged as bow and stern chasers, to be placed on central pivot mountings supporting segmental shields. These are mounted on the spar deck—one forward and one aft—with a range of 120 degrees.

Four 6-in. guns are arranged in sponsons on the main deck, two commanding a range from right aft to 25 de-



UPPER DECK PLAN.



ELEVATION.

DESIGN FOR ARMORED BATTLE-SHIP, U. S. NAVY.

grees forward of the beam, and two a range from right forward to 25 degrees abaft the beam. Six tubes are also provided for ejecting torpedoes.

Two military masts are fitted to carry machine guns.

THE ARMORED CRUISER.

The Board did not recommend the adoption of any of the designs submitted for the armored cruiser, and before making any decision, a careful examination of these plans is to be made. It is thought probable that the design prepared by the Bureau of Construction of the Navy Department may be adopted. This plan, as has been heretofore noted, has many points of resemblance to the celebrated Brazilian turret-ship *Riachuelo*, although many improvements in the original model have been introduced. The general dimensions are as follows: Length, 310 ft.; breadth, 54 ft.; draught, 21 ft. 6 in.; displacement, 6,600 tons; speed, 17 knots; coal capacity, 800 tons. Four 10-in. guns are carried in turrets *en echelon*, and six 6-in. guns are mounted in central pivot carriages, so arranged that all of the 10-in. and three of the 6-in. guns can be concentrated on one point of fire, while 13 rapid-fire guns have practically an all-around range. The armor belt is 17 in. in thickness and 6 ft. in breadth. The vessel will be fitted with torpedo tubes for the discharge of fish torpedoes, carries two steam torpedo boats, and is rigged as a bark.

Hydro-Pneumatic Disappearing Gun-Carriage.

THE accompanying engravings show a disappearing gun-carriage, on the hydro-pneumatic system, made at the works of Sir W. G. Armstrong, Mitchell & Co., and shown at the Exhibition at Newcastle, England.

In the system illustrated, the recoil set up on firing the gun is utilized for compressing air in a chamber of the recoil-cylinder, by means of water or other fluid which is forced from the outer chamber through a valve into the air chamber. At the same time the movement of the ram in the cylinder is communicated, by means of a crosshead, to a pair of elevating levers, in the upper ends of which the gun trunnions are carried, the lower ends being connected to the gun-carriage. On being fired, the traverse of the ram causes the elevating levers to descend, carrying the gun with them, and, as above stated, compressing the air in the recoil-chamber at the same time. When the gun has been loaded in its lowest position this energy is utilized for raising it, as shown in the lower view of our illustration, into the firing position.

The engravings given show the construction of the apparatus very clearly. It has excited much interest in the Exhibition.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 309.*)

WE continue below the condensed summary of the reports of the Board of Trade inspectors on accidents resulting from breakages of wheels and tires on British railroads. This summary was begun in the June number of the JOURNAL, and its purpose and object were there explained.

In the last number these condensed reports were brought down to the close of 1872, and the record is now taken up from the beginning of the year 1873.

ACCIDENT REPORTS.

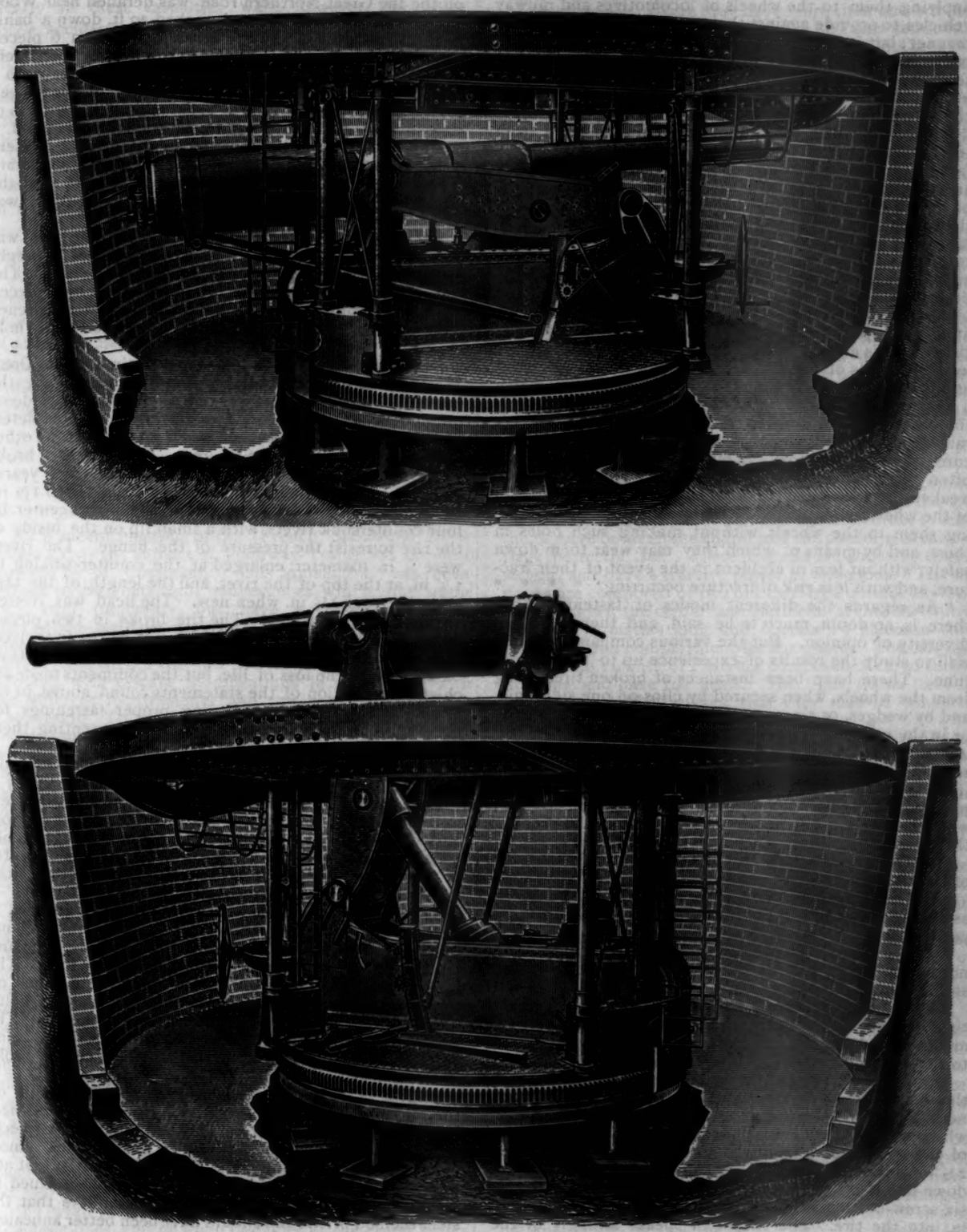
January 6, 1873, as an express train on the Midland line was near Royston, a tire broke on a leading wheel of the engine and flew off, throwing the engine from the track. A passenger was hurt. The tire broke into 6 pieces, which were, respectively, 65, 13, 26, 22, 4½ and 24½ in. long; they were scattered along for some 600 ft. beside the track. Some 200 ties and 25 rails were broken by the train. The tire was of crucible steel and had run 50,438 miles, wearing down from 2½ to 2⅜ in. It was secured to the wheel-center by 6 set-screws, each ⅞ in. in diameter and penetrating 1⅛ in. into the tire. Three of the breaks were through bolt-holes. In this case the Inspector comments very severely on the insufficient method of fastening the tires used.

January 8, 1873, a tire broke under a passenger carriage of an express train on the Midland Railway, near Dore. The carriage did not leave the track, but one passenger was hurt by a piece of the tire which was thrown up through the floor This tire was of iron, originally 2-in. thick on tread, but worn down to 1¾ in.; it was fastened to the wheel-center by four rivets. It broke into 6 pieces, 44, 33, 8½, 13½, 22 and 12 in. long respectively, four of the fractures being through bolt-holes. The Inspector again urges the use of such fastenings as will hold the tire in place even if broken.

April 28, 1873, a tire broke on a driving wheel of the engine of a passenger train on the Midland Road, near Stenson Junction. The wheel was 6 ft. 6 in. diameter; the tire had been last turned up in January, 1873, the engine having been in service since 1852. The tire was originally 2½ in. thick on tread, but had been reduced to 1⅜ in. by wear and turning. It was fastened to the wheel-center by 7 bolts, ⅞ in. diameter. It broke into 6 pieces, and no flaws were found in the metal. The inspector thinks that this breakage was the result of trusting too long to a worn-out tire, and again urges the use of better fastenings.

May 1, 1873, a passenger train on the Great Western was derailed near Upton Magna, by a broken tire under a brake-van, all the train except the engine leaving the rails; a guard and 11 passengers were hurt. The tire broke into 11 pieces, which were scattered for 400 ft. along the line. The tire was iron and seems to have broken first at the weld, where a slight flaw was found. Another crack or flaw was found at a second break, but neither of these flaws was large enough to seriously impair the strength. The fastening to the wheel-center was by the Gibson method, in which a circular key-ring is used, fitting into a groove in the tire. It seems that this groove was defective at one point, and a piece had been cut out of the key-ring. This ring disappeared when the tire broke, and had not been found when the report was made. The tire was of iron, and tests made on the pieces showed that the metal was somewhat brittle. The Inspector says: "The Great Western Company has about 100,000 wheels on which the tires are fastened in the same manner; and I am informed by Mr. Armstrong, the Locomotive Superintendent, that he has only known one instance in which a tire after breaking has left a 42-in. wheel. * * * * As it is impossible to prevent tires from breaking occasionally, in consequence of hidden flaws or some imperfection in the metal, it is of paramount importance to prevent them from leaving the wheel-center when breakage does occur."

June 21, 1873, an excursion train on the Midland Railway was derailed near Wingfield by the breaking of a tire on a leading wheel of the engine. The engine, brake-van, and 4 carriages were derailed, killing 2 passengers, seriously injuring 3 trainmen and 12 passengers. The engine in this case was a six-wheels coupled engine, with 16½ by 24 in. cylinders, and wheels 62½ in. diameter; it weighed 33½ tons, about 11 tons being on the leading wheels. The tire which broke was of crucible steel; it had run 117,154 miles and had been reduced from wear and turning from 2½ to 1¾ in. thick on thread. It was secured to the wheel-center by 8 screw-bolts or set-screws, each 1 in. in diameter, and tapped about 1 in. into the tread of the tire. The tire was found to be in five pieces, 72½, 46¼, 32½, 26½ and 12 in. long, respectively. This case seemed of so much importance that, in the course of the investigation, letters were sent to all the railroads in the country, asking them to give statements



HYDRO-PNEUMATIC DISAPPEARING GUN-CARRIAGE.

MADE BY SIR W. G. ARMSTRONG, MITCHELL & CO., ELSWICK, ENGLAND.

as to the method of fastening tires in use on their respective lines.

In summing up this case, the Inspector says: "It is probably impossible, in the manufacture of tires and in applying them to the wheels of locomotives and railway vehicles, to provide against their occasional failure in this manner; but it is possible, as I have frequently and for many years had occasion to point out, almost absolutely to prevent danger to passengers and trainmen in the event of their failing, by attaching them to the rims of the wheel-centers by methods which will prevent them flying off the wheel when broken. They may fail from too brittle nature of the material, from defects of manufacture, or from being too tightly shrunk on to the wheel; and they have frequently failed from one of these causes, or from a combination of them. The danger is not in the fracture, or in the tire being divided into two or more parts, but in the probability of the tire, which is or ought to be, in a state of tension on the wheel, flying suddenly and violently from it when fracture occurs; and this danger is greater with steel than with iron tires. The loss of a tire from a wheel in any part of a train traveling at a high speed, must always be an occasion of serious risk, but it is especially so with regard to the tires on the leading wheels of the engine. The risk being so great and the remedy so simple, involving no extra cost worth a moment's consideration, it does appear surprising that there should have been so much difficulty in inducing railroad companies to adopt this remedy. Having procured the best tires they can manufacture or buy, they too often proceed to bore great holes in them and so to weaken them seriously, in order to fasten them to the rim of the wheel, when there are superior methods of attaching them to the wheels without making such holes in them, and by means of which they may wear them down safely, without fear of accident in the event of their fracture, and with less risk of fracture occurring. * * * *

"As regards the different modes of fastening tires, there is, no doubt, much to be said, and there is much diversity of opinion. But the various companies will do well to study the results of experience up to the present time. There have been instances of broken tires flying from the wheels, when secured by clips on one side only, and by wedges, or rings, or bolts only, on the other side or in the middle. There have also been cases of the failure of wooden wheels. But there has not yet been a case, so far as I am aware, of a tire flying from a wheel when the double-clip system has been adopted, and this system may be and has been adopted with iron, as well as with wooden wheels. The principles which appear to promise the greatest degree of safety may thus be stated:

"1. There should be a clip of some sort on each side of the tire, and not on one side only.

"2. The clips should be formed with square shoulders, as I pointed out in a report on tire-fastenings nearly 13 years ago, and not with a slanting dovetail.

"3. The clips should be continuous on both sides, and not intermittent (with spaces between the portions) on one side, as they are in some cases.

"4. The strength of the clips, and of the portion of the tires clipped, should be in proportion to the strains which are liable to be brought to bear upon them, having regard to the material and strength of the tires."

December 12, 1873, a tire broke on the leading wheel of the locomotive of a passenger train, on the Midland road near Spondon; the train was not derailed. The tire, which was of crucible steel, broke into seven pieces, two of the breaks being through bolt-holes. It was originally 2½ in. thick on the tread, but had been turned and worn down to 1⅞ in. It was fastened to the wheel-center by six screw-bolts passing through the rim and entering 1¼ in. into the tire. The Inspector speaks strongly of the defective fastenings of the tire.

December 13, 1873, on the Northeastern Railway, near Guisboro Junction, a tire came off a wheel under the tender. The tire was of Low Moor iron, 42 in. diameter, and was secured to the wheel-center by three rivets. The tire did not break, but it was found that all of the rivets were broken, one showing a fresh break, the other two having apparently been broken for some time. The Inspector believes that the breakage of the rivets was due to expansion of the tire by heat, resulting from friction of the brake-blocks.

December 28, 1873, the brake-van of a passenger train on the the Great Northern road was derailed near Wood Walton, by a broken tire and pitched 30 ft. down a bank. About two-thirds of the tire left the wheel in 6 pieces, the remaining third being held to the wheel by the fastenings; these consisted of 8 L-shaped clips, fitting into a groove in the tire, and secured to the rim of the wheel-center by screw-bolts, one in each clip. The tire was of steel, five years old, and was 1¾ in. thick on the tread.

May 8, 1874, a tire broke under a carriage in a passenger train on the Dublin, Wicklow & Wexford line, derailing the whole train. The tire broke at a weld, and the wheel-center, which in this case was cast-iron, was broken to pieces.

July 17, 1874, mixed train on Northeastern line was derailed near Chat Hill, by a broken tire under a freight wagon. A trainmen and 3 passengers were hurt. The tire, which was of very poor iron, broke into four pieces, the breaks being at the bolt-holes where it was fastened to the center. The fastenings were insufficient to hold the tire.

December 24, 1874, a passenger train on the Great Western was derailed near Shipton-on-Cherwell, by the breaking of a tire. This was one of the worst accidents on the record, several carriages having been completely wrecked, 30 passengers killed and 4 fatally hurt, 65 other passengers and 4 trainmen injured. The tire which broke was of Low Moor iron, and had been in service 9 years; it had been worn and turned down from 2½ to 1⅞ in. thick on tread. It was fastened to the wheel-center by four countersunk rivets, with a small lip on the inside of the tire to resist the pressure of the flange. The rivets were ¾ in. diameter, enlarged at the counter-sinking to 1¼ in. at the top of the rivet, and the length of the tapering part was 1½ in. when new. The head was riveted up hot in the usual way. The tire broke in two pieces, about 3 and 8 ft. long, and three out of the four rivets broke. In this case there was an extended investigation, on account of the loss of life, but the comments made are chiefly a repetition of the statements found above, in relation to the necessity of using proper fastenings for tires, and of employing some means of preventing them from leaving the wheel-center when broken.

January 2, 1875, passenger train on North British Railway was thrown from the track near Buchlyore, by a broken tire under a passenger carriage, and 10 passengers were hurt. The broken tire was 52 in. diameter of iron, and was about 1½ in. thick on thread, although somewhat unevenly worn; it was secured to the wheel-center by five ⅞-in. rivets. It broke into four pieces, all the breaks being through rivet-holes.

August 21, 1875, a passenger train on the Waterford & Limerick line, was derailed near Long Pavement, Ireland, by a broken tire on a leading wheel of the engine. The fireman was killed, the engineer and a passenger hurt. The broken tire was of steel 4 ft. diameter and 2 in. thick on tread; it was fastened to the wheel-center by five ⅞ in. bolts, with countersunk heads 1⅛ in. diameter in the tire. The tire broke into three pieces, two of the breaks being through bolt-holes. The rim of the wheel-center broke in two places.

August 24, 1875, two carriages of a passenger train on the Midland Railway were thrown from the track near Kilnhurst by a broken tire. This tire broke in two pieces and left the wheel altogether. It was of steel, almost new (in use 38 days only), and broke, apparently, first at a bolt-hole, and then at a point where a flaw seemed to have occurred in rolling it. The Inspector says that the steel seemed brittle and should have been better annealed. It was held to the wheel-center by four ⅞ in. bolts, with countersunk heads, tapering from 1⅛ to ⅞ in. The Inspector censures the company very severely for continuing to use fastenings which had proved unsafe and insufficient years before, when so many better systems were in use on other lines.

For the year 1874, the total number of accidents given by the companies' reports, made under the law, from

broken tires, was 55, and from broken wheels 13; a total of 68 accidents. In these accidents, 34 passengers were killed, 66 passengers and 7 employes were injured. Nearly all these casualties were, however, due to a single accident, most of the accidents having been slight in their results.

It will be observed that, in only three out of these 68 accidents, was it considered necessary to hold a special examination, and only three of them are mentioned above.

From 1847 to 1874, inclusive, the Inspectors examined into and reported on 81 accidents, resulting from breakage of tires. The total number killed in these 81 accidents was 65 passengers and 8 employés; injured, 268 passengers and 38 employés.

As in the earlier reports, there were exceedingly few breakages of wheel-centers included in these reports, and in almost every case these breakages resulted from failure of tires. In nearly every case where the tires broke, the damage done would have been slight had the tire been sufficiently fastened. Safe fastenings seem to be the burden of the Inspectors' reports throughout.

(*To be continued.*)

Tramway-Trains

AT a recent meeting of the (French) *Société des Ingenieurs Civils* the subject of Tramway-Trains was brought forward by M. Cossmann. This appellation has been chosen to designate light conveyances which, like tramcars, stop frequently, but have a velocity equal to that of the ordinary trains. It is nearly 10 years since they were first tried in Austria, and in the environs of Berlin; from thence the idea spread into France and was adopted with certain modifications in accordance with the different requirements and the restrictions of the Legislature. To authorise a departure from existing regulations a presidential decree was found necessary, which was granted on the application of the Administration of the State Railways. The three articles of this decree related to the length of the train, the number of men accompanying each train, and the precautionary measures to be observed *en route* and at the stations; the rate of speed also to be determined by ministerial orders.

The question appears to have fallen into abeyance for about two years. At the end of that time, in 1884, the Compagnie du Nord, alarmed at the falling off of their traffic, took measures to reduce the working expenses of each line in proportion to the receipts, and resolved to try the system of tramway-trains on a branch of their Belgian line, and on two of their French lines. The system had already been applied in a suburb of Liege, on a line running between that town and Maëstricht. Of the two French lines, that between Lille and Tourcoing was considered suitable for the trial of a single carriage tramway-train, and on the line running from Boulogne to St. Omer, it was thought that light trains composed of several carriages would be better fitted to the requirements of the traffic. The results of this decided the company to develop and extend the application to several sections.

Other French companies are beginning to follow the example of the Compagnie du Nord. To the east, there are two lines in the Department of Meurthe-et-Moselle; to the west, it is proposed to extend the system to the Bretagne lines, and to some branches of the Seine Valley.

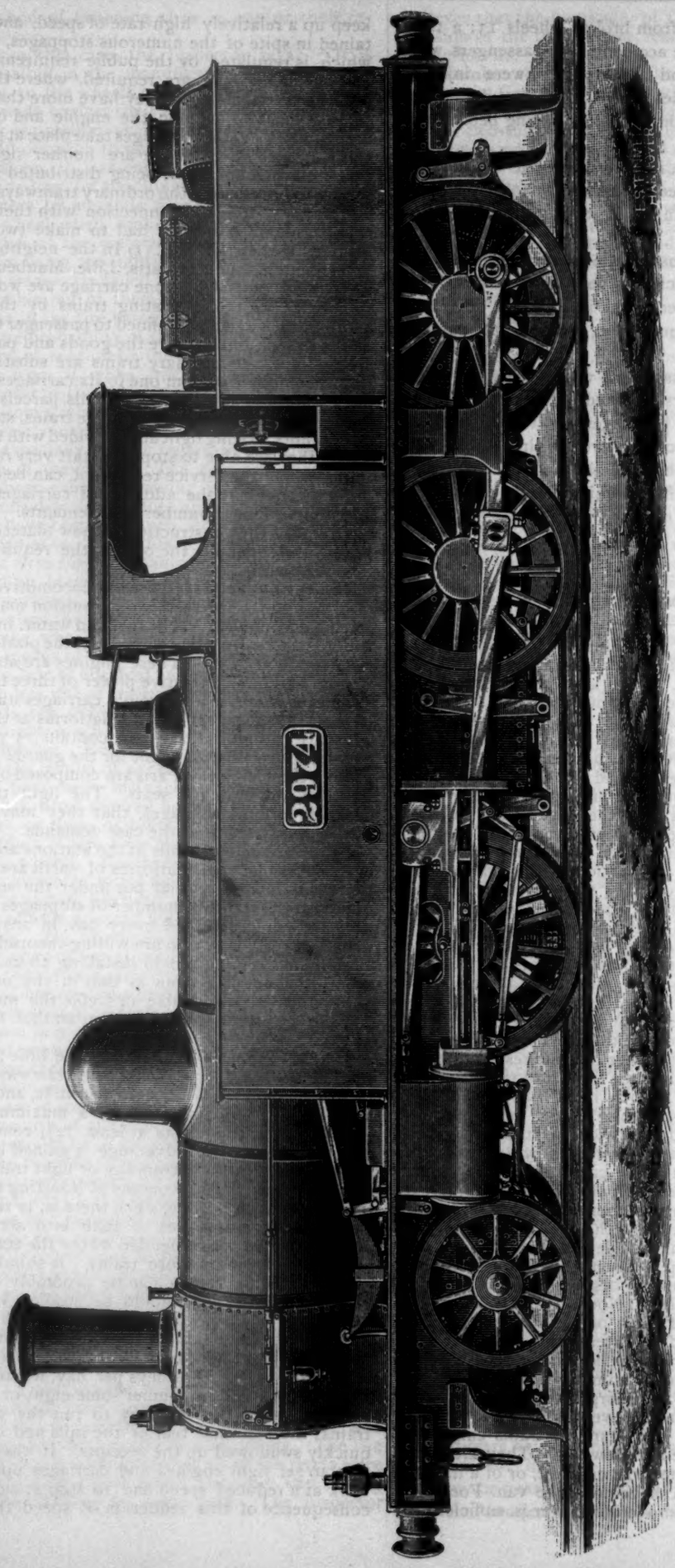
Since the 21st of September tramway-trains have been running from Villeneuve-St. Georges to Palaiseau, and an extension is contemplated between Plaine and Pantin.

The characteristics of the tramway-trains employed over the Northern line are as follows:—(1) They are composed of an engine and one large carriage, or of a limited number of carriages, and have no brake van. For such light trains an engine of moderate power is sufficient to keep up a relatively high rate of speed, and this is maintained in spite of the numerous stoppages, the number of which is regulated by the public requirements. A driver and one guard only are required, where the trains have but one carriage; where they have more than one but less than seven, two men on the engine and one conductor are requisite; (2) the stoppages take place at points between the stations, where there are neither signal boxes nor ticket offices, the tickets being distributed in the train itself by the guard as in the ordinary tramways. In establishing tramway-trains in connection with their railways, the Compagnie du Nord has had to make two distinct provisions for their service; (1) In the neighborhood of the great centers, such as Paris, Lille, Maubeuge, the tramway-trains composed of one carriage are worked in correspondence with the existing trains by the addition of another track and are confined to passenger traffic only; (2) on the branch lines, where the goods and passenger traffic are distinct, the ordinary trains are substituted by light trains, composed of from one to six carriages at most, without a brake-van; they carry the mails, parcels and passenger luggage, and, like the one-carriage trains, stop at intermediate points. Being light and provided with the continuous brake, they are able to stop and start very rapidly. These trains, where the service requires it, can be converted into ordinary trains by the addition of carriages, a brake-van and the ordinary number of attendants. The company has avoided the construction of new material, and has, in most cases, adapted the old to the requirements of the new service.

The engines employed are old locomotives, the tenders of which are suppressed, and provision made at the side for the accommodation of fuel and water, in order to leave the passage between the engine and the platform of the carriage perfectly free. These engines are about 15 tons in weight, and have a tractive power of three tons. The carriages are composed of two old carriages united, having a passage down the center and platforms at the extremities. They are 11 meters long, and contain 75 places in three classes, with a compartment for the guard. The carriages used in the vicinity of Paris are composed of three thrown into one, and have 102 seats. The light trains have the common form of carriages, that they may be converted into ordinary trains as the case demands.

The arrangements made at the stations are as rudimentary as possible; two platforms of earth are formed, contiguous to a crossing, and put under the superintendence of an attendant. The number of stoppages is now 47, and they are being increased every day, in answer to the demands of residents, who are willing themselves to bear the slight expense incurred in installing them. The rate of speed is about the same as that of the ordinary trains; although there are double or treble the number of stoppages, they are of short duration, so that but little time is lost.

Taking the results obtained on the Lille and Tourcoing line, the working expenses of the tramway-trains of one carriage amount to 13 cents per mile, and those of the light trains of six carriages to a maximum of 19 cents, while a mixed train costs at least 22½ cents. It will be seen then that a real advantage is gained in substituting the ordinary trains by tramway or light trains. It is more difficult to justify the economy of inserting tramway-trains into the existing service, since there is, in the first place, a supplement of expenses to take into account, but the system is to be recommended where the traffic is likely to increase and require more trains. It should not be concluded that this system can be profitably applied everywhere; the question should be studied line by line to determine where it could be adopted with advantage or otherwise. The object in view in starting tramway-trains in Austria was to promote local traffic. To provide for at least three or four journeys per day, where the travelers would not exceed in number some eight or twelve persons per journey, it did not pay to run the ordinary heavy trains; the wear and tear of the rails and other expenses quickly swallowed up the receipts. It was decided, therefore, to set light engines and carriages upon the rails, to work at a reduced speed and to stop at close stages. In consequence of this reduction of speed they have been



COMPOUND TANK LOCOMOTIVE FOR FREIGHT SERVICE.

BUILT AT THE LONDON & NORTHWESTERN SHOPS, CREWE, ENGLAND: F. W. WEBB, CHIEF MECHANICAL ENGINEER.

able in Austria to reduce the tariff 33⅓ per cent. below the ordinary prices.

According to M. Kopp, the receipts in the suburbs of Vienna in 1880 amounted to about 38 cents per mile and the expenses to 17½ cents only. The speed is generally fixed at 18 or 19 miles per hour, and descends in some cases as low as 14 miles. The project has been worked out very successfully, and the example has been followed by Germany, France, Italy and Belgium. In the latter country, however, the general use of tramway trains is still under consideration; as yet they are only employed around Liege and on the Chirnay line.

Compound Tank Locomotive.

THE accompanying illustration is a perspective view of a compound locomotive, intended for freight traffic, and built at the Crewe Works of the London & Northwestern Railway, from the designs of Mr. F. W. Webb, Chief Mechanical Engineer. The engine has side-tanks and is carried on four pairs of wheels, of which three pairs are drivers, while the leading wheels are fitted with Mr. Webb's well-known radial axle-box. The system is very much the same as in the *Dreadnought* and other compound passenger engines of the same class built by Mr. Webb. The high and low pressure cylinders work on different axles, which are not coupled or connected.

In the present engines, as will be seen from the engraving, the two hind pairs of wheels are coupled, and are driven by the pair of high-pressure cylinders, these cylinders being 14 in. in diameter and 24 in. stroke. As in the case of Mr. Webb's other compounds, the valve gear is of the Joy pattern, but, owing to the small size of the wheels, the valve chests of the high-pressure cylinders have to be placed above the cylinders, instead of below, as in the compounds for fast passenger service.

The axle of the front pair of driving wheels has a single central crank, to which the piston of the low-pressure cylinder is coupled, this cylinder being 30 in. in diameter, with 24 in. stroke. The cylinders of this engine, now illustrated, are of the same sizes as those of Mr. Webb's *Dreadnought* class of passenger engines, about which so much has been written.

The driving wheels of the engine under notice are 5 ft. 2½ in., and the leading wheels 3 ft. 9 in. in diameter. The total wheel base is 21 ft. 6 in., of which 14 ft. is the wheel base of the three pairs of driving wheels. The boiler is worked at a pressure of 160 lbs. per square inch and has 1,099 square feet of heating surface, of which 95 square feet is firebox surface, and 1,004 square feet tube surface. The grate area is 17.1 square feet, and the weight of the engine, empty, is 43½ tons. The tanks carry 1,400 gallons of water.

Engines of this class are, it is stated, doing very good service on the London & Northwestern road. Mr. Webb promises to publish hereafter some particulars of their work.

A Problem in Profit-Sharing.

[Abstract of Paper read before the American Society of Mechanical Engineers at the Washington meeting by Mr. William Kent, of New York.]

IF we admit that sharing of profits among the workmen will benefit both employers and employed, on what basis should profits be divided in a business in which they depend rather upon the selling than upon the manufacturing department?

Suppose three manufacturing companies—A, B and C—each produces per year 100,000 of an article which, under average conditions, costs $1 for labor, material and shop-expenses. It is sold by advertising, by agents and by discounts at a cost of, say, $100,000 per year. The average selling price is $2.10. All three concerns being on the same footing, each makes 10 cents profit on one article, or a total of $10,000 a year.

Suppose that the next year, the average selling price is reduced to $1.50. A then, to cheapen production, introduces the profit-sharing system, and, in expectation of sharing profits, the workmen become so much more efficient that the cost of production, for labor, material and shop-expenses, is reduced to 75 cents, the stipulated daily wages being reduced 5 per cent., and the production increased 25 per cent. The selling organization and expenses remain the same as in the preceding year, being $100,000, or 80 cents on each of the 125,000 articles. The total cost for production and sale is, therefore, $1.55, or 5 cents more than the selling price, making a loss of $6,250, and no profits to be divided among the workmen, although their wages were reduced 5 per cent. in expectation of such profits.

B puts in better machinery, runs overtime, pays the same wages as before, doubles its product and reduces the cost of production to 80 cents. More liberal advertising and more agents increase the selling expense to $120,000, which, divided by 200,000 articles sold, is 60 cents each. The profit and loss account then shows:

200,000 manufacturing cost at 80c.	$160,000
do. selling expense cost at 60c.	120,000
Total cost	$280,000
do. sold at $1.50	300,000
Profit	$20,000

C thinks its selling department costs too much, cuts down salaries, commissions and advertising, so that the yearly expense of selling is reduced to $40,000; does not increase the quantity of business as A and B did, but sells 100,000. No change being made in manufacturing, the article costs, as before, $1 each. Result:

100,000 manufacturing cost at $1	$100,000
do. selling expense at 40c.	40,000
Total cost	$140,000
do. sold at $1.50	150,000
Profit	$10,000

A has the most efficient workmen, who give up 5 per cent. of their wages, and reduce the cost of production 25 per cent., yet these, through no fault of their own, get no profits, and less wages than the workmen of B and C. B and C both pay their workmen as before, and both make a profit through the adoption of two opposite lines of policy, B spending money more liberally, C cutting down expenses.

Does not this show that, if profit-sharing be adopted where selling of the articles is entirely separate from making them, the share of the workmen should be calculated not on the profits of the whole business, but on the savings in the manufacturing department alone?

A's workmen were entitled to a share in the 25 per cent. which they saved in manufacturing; and if the selling department had been managed like those of B or C they would have obtained it. Had B and C adopted the profit-sharing system in addition to change of policy in selling, their profits would have been still greater, for their cost of production would have been reduced.

The following is suggested as a fair basis: From the statistics of a year's production make an estimate of the cost for labor and shop-expenses. Call this the maximum allowable cost for the next year. Pay the same daily wages as before, and, at the end of the year, in addition, a certain percentage, agreed on at the beginning of the year, of the difference between the maximum allowable cost and the actual cost, if there has been a saving. It might be fair to deduct from the maximum cost any saving clearly due to introduction of new machinery or expenditure of capital, and not to increased efficiency of workmen.

The following is an example under this method:

No. of pieces made.	Material.	Labor.	Shop Expenses.	Total.	Labor and s. ex. only
1st year, 100,000	$20,000	$60,000	$20,000	$100,000	$80,000
Each piece costs	20c.	60c.	20c.	1.00	80c.
2d year, 150,000	30,000	70,000	20,000	120,000	90,000
Each piece costs	20c.	46⅔c.	13⅓c.	80c.	60c.

Maximum allowable cost for labor and shop expenses 150,000 at 80c.	$120,000
Actual cost 150,000 at 60c.	90,000
Saving.	$30,000

This saving of $30,000 is to be divided between the employers and employés in proportions previously agreed upon. The shop expenses, including rent, taxes, insurance, gas, fuel, wages of superintendents and clerks in manufacturing department and wear and tear of machinery, are properly included in the amount upon which savings should be calculated; since, if their total cost is a fixed sum per year, the cost per piece produced depends upon the number of pieces made, and hence, to a great extent, upon the efficiency of the workmen. The cost of the raw material is not included, because this depends upon fluctuations of market, and to some extent upon foresight and judgment of the purchasing department, and generally not upon the efficiency of the workmen. Material spoiled, or excessive waste of material, might be charged as part of cost of labor.

By this method the profits to be divided among the workmen are are those which they make themselves by more rapid work, carefulness in avoiding waste and by general increase of skill. It removes the most serious objection, that it is easy for the capitalist to share profits with his workmen, but impossible for the workmen to share in the losses, which the capitalist must bear himself. It makes the workmen share the losses if there are any in the manufacturing department, in which department alone the workman is concerned. He shares neither the profits nor the losses of the purchasing and the selling departments, with which he has nothing to do.

Steel Ties on the Netherlands State Railroad.

[Paper by M. G. Braet, Engineer of Maintenance of Way, Belgian State Railroads, in the *Bulletin* of the International Railroad Congress.]

THE company operating the Netherlands State Railroad put in service several months ago, on a line traveled by express trains between the stations of Tilbourg and Breda, a new rail-section carried on metallic ties of the modified Post type.

The modified Post tie has the form of an inverted

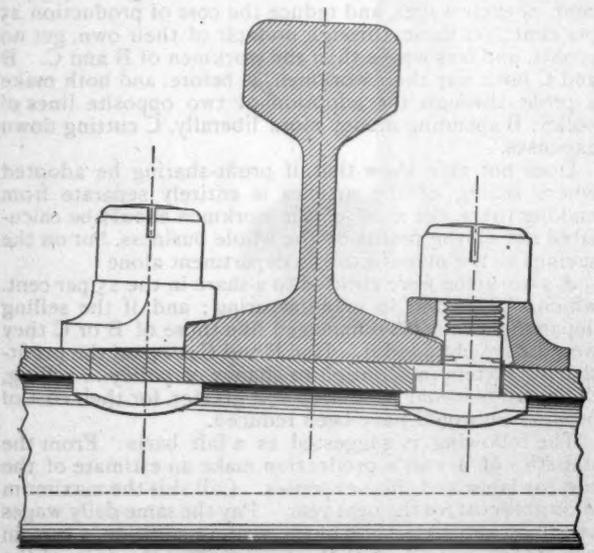


Fig. 1.

(*Inclination of rail, 1 in 20.*)

trough of a regular polygonal section (fig. 3) with rounded angles; its lateral faces, which are at an oblique angle, are provided below with a small rib or projection intended to facilitate penetration into the ballast. The upper surface of the table is curved at the ends and falls below the general surface of the tie in such a way as to take hold in the ballast, and, consequently, to oppose the tendency to displacement transversely to the rail.

The lower sides of the tie, which are horizontal for a distance of 85 centimeters (34½ in.) from the ends, are arched downwards toward the middle, in such a way as to induce the lateral faces of support to imbed themselves in the ballast and thus to oppose the tendency to movement in the direction of the length of the rail.

In the upper surface or plan of the tie, the top or table widens at the ends and is drawn in at the center. The widening at the end furnishes a greater supporting surface, and, consequently, contributes in some measure to the stability of the rail.

As to this narrowing in the middle of the tie, M. Post, the Engineer of the company, sees in it a special advantage for roads with poor ballast, and where the tamping is little cared for. In roads which are placed under such unfavorable conditions, the tie, if of uniform size, forces itself down into the ballast and often finds a point of rest in the center, causing an oscillation or rocking movement

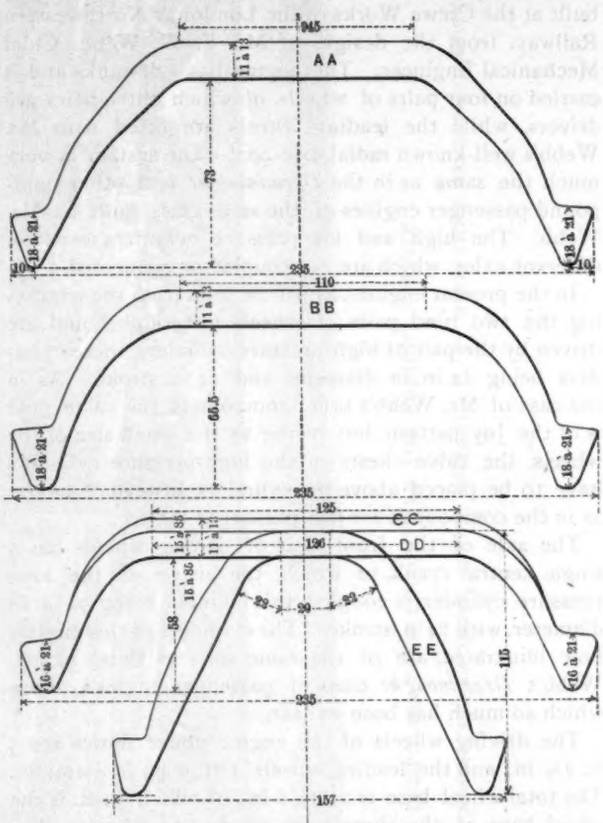


Fig. 3

(*Measurements in millimeters.*)

of the track. The reduction of size in the center of the tie, while diminishing the reaction of the ballast at that point, will result in keeping the principal resistance at the outside near the rails. At the same time, the increase of height at the end of the tie increases considerably its stiffness, and keeps it from bending while being transported to the road or in a neglected track.

The rails, which weigh 40 kilogrammes to the meter (80 lbs. per yard), are secured to the ties by clips or washers, of a form shown in the cut, and by bolts with Ibbotson nut-locks.

We will now see under what conditions the experiments with steel ties are made.

A model section of 576 meters (1,890 ft.) long on the modified Post ties of steel, with rails 12 meters long and weighing 40 kilogrammes per meter, is placed between another section of the same length (576 meters) laid with rails 33.7 kilogrammes to the meter (68 lbs. per yard), and 9 meters long, on Post steel ties of the old pattern, 10 ties to each length of rail, and a standard section 576 meters long, with rails of 40 kilogrammes to the meter and 12 meters long, laid on oak ties presenting 10 centimeters of

bearing to the rail. Each of these ties is furnished with two barbed spikes of the Post pattern. This last standard section on wooden ties is followed by another section of 576 meters in length, with rails 33.7 kilogrammes to the meter, and 9 meters long, on steel ties of a rectangular section.

These different sections are on a grade of 1 in 676, and are all ballasted with fine gravel.

From the preceding statements it will be seen that each model section of the track is placed next to a standard section of road, of the same nature from the point of view of the road-bed, the place and the travel being under conditions identical, or, at least, very closely similar. This trial, which is now actually in progress in Holland, is then a strictly comparative one for track upon metallic ties and track upon wooden ties, and it will lead, with the trials which the same company has been making since 1880, on its Liege-Limbourg line, to results which should be absolutely sure and conclusive.

Experiments made in so intelligent a manner will necessarily have very great interest for railroad managements which intend to introduce metallic sub-structure on their

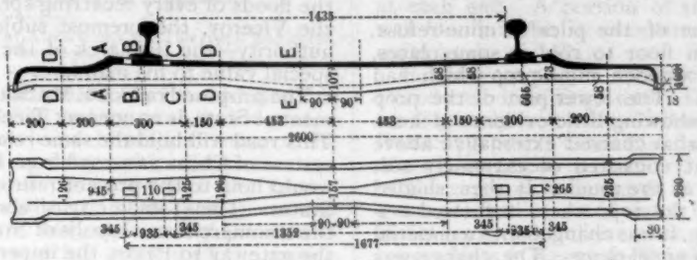


Fig. 2

(*Measurements in millimeters.*)

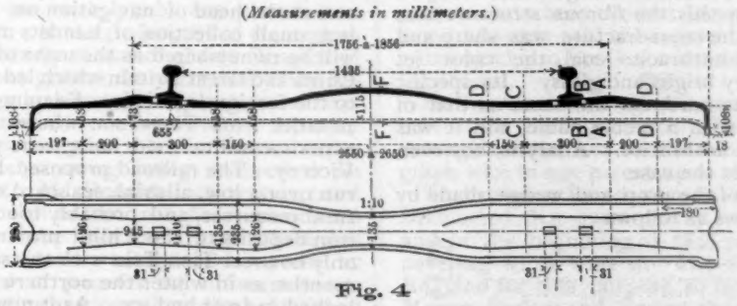


Fig. 4

lines, and we propose to follow them very closely, in order that we may be able finally to complete the present notice by an announcement of the results obtained.

It remains that we should state the work which these different sections of road have to do, and indicate the cost of the track on the Post modified plan. Thanks to the kindness of M. Post, the Engineer, we have ascertained that the total number of trains passing daily from Tilbourg to Breda is 22, of which 14 are passenger and 8 freight trains. The maximum speed is that of the mail train, which may be estimated at 75 kilometers (46½ miles) an hour. As to the weight of the heaviest train, it is about 978 tons, or, perhaps, with the engine and tender, 1,046 tons.

The cost of the track upon metallic ties of the modified Post type is about as follows, the weights given being in kilogrammes:

Material for 12.007 meters of track, Post modified type.

	Weight. Each.	Weight. Total.
2 Steel rails, 12 meters long, 40 kilogrammes per meter..	480.000	960.000
2 Steel joint-plates, inside.....	10.270	20.540
2 " " outside.....	10.260	20.520
14 Steel cross-ties.....	60.000	840.000
56 Clips, wrought-iron.....	0.435	24.360
56 Steel bolts, with Ibbotson nut-locks.....	0.736	42.336
8 Steel joint-bolts, with Ibbotson nut-locks.....	0 768	6.144
Total weight.....		1,913.900
Weight per meter.....		159.399

The cost of the materials delivered at Breda was 20.39 francs per meter ($3.60 per yard). The cost with clips of steel, ordinary bolts and Verona nut-locks was 18.89 francs per meter ($3.33 per yard). The cost of road on the standard Post tie of the old pattern was 15.54 francs per meter, the total weight of material being 132 kilogrammes per meter. (The Post improved tie weighs 132¼ lbs. without clips or bolts.)

We understand that the use of the Ibbotson nut-lock increases by about 8 per cent. the price per meter of track, and by about 13 per cent. the cost of the tie with its attachments. So far, the new tie has shown very good results and has left nothing to be desired in the way of stability. It is with difficulty that, when a train passes, the slightest movement of the ties can be noticed, so well are they anchored in the ballast. On the other hand, if one can judge, the cost of maintenance appears to be much below that of ordinary track upon wooden ties.

It will, however, be possible to decide definitely upon this only after a much longer experience.

The company operating the Netherlands State railroads deserves a great deal of credit for its resolution to solve the important problem of metallic sub-structure; efforts which have already much advanced our knowledge on this question. Special credit is due to M. Post, Engineer of the company.

We understand that this gentleman is now designing a new form of his tie, which he calls a tie of the "dromedary" form. In this form of tie (fig. 4), the under surface, which is imbedded in the ballast, forms a straight line, and the top of the tie is raised or arched in the center in such a way that this central part never finds a point of support upon the ballast.

The tie above referred to as the modified Post tie is shown in figs. 1, 2 and 3; fig. 1 showing the position of the rail upon the ties; fig. 2 a longitudinal section of the tie upon a much smaller scale, and fig. 3, cross sections of the tie at various points of its length. Fig. 4 shows a longitudinal section of the new or "dromedary" pattern of tie.

The Netherlands State Company intends to put in its track, by way of trial during the present year, about 8,000 ties of the "dromedary" pattern, and it will also try several thousand clips or washers of cast-steel, which have thus far given better results, although the price is much lower than those of wrought-iron.

Note On the Formation of Coal from Mine Timber.

[Read before the American Institute of Mining Engineers, by Mr. E. S. Moffat, of Scranton, Pa.].

MEMBERS of the Institute who have visited the works of the Lackawanna Iron & Coal Company at Scranton will remember the exposure of a large vein of anthracite coal in the rocky bank on the south side of Roaring Brook, near the blast-furnace. The vein is quite flat, and

is exposed to view for several hundred yards along the banks of the brook, a few feet above the surface of the water. It is some 10 ft. in thickness, and is known as the Big Vein. At a point just opposite the blast-furnace, much of the coal from this vein was mined out many years since, the usual pillars being left to support the overlying rock and drift, which are here some 25 to 30 ft. in thickness.

Over 30 years ago fire was communicated from an ore-roasting pile on the surface of the ground at this point, through an old shaft, down to the refuse and pillars which had been left in the mine below. Ineffectual attempts were made at that time to extinguish the fire, and it was finally decided to seal the mine up and smother the fire by the exclusion of air. All the openings were walled up tightly, and the mine was left undisturbed until a couple of years ago, when it was thought best to open it again and examine its condition. It was found to be still smouldering, and the fire burned up briskly as soon as air was freely admitted. Systematic measures were then taken to extinguish the fire by deluging it with water, and by working around it and cutting off any further progress.

In working through one of the piles of mine-refuse, which filled the vein from floor to roof in some places, the miners came upon a wooden mine-prop which had become curiously altered. The lower part of the prop was well-preserved wood, showing little evidence of heat. Half way up it was somewhat charred externally; above this, for some distance, it consisted of extremely soft charcoal, which crumbled at the touch. It then shaded into hard charcoal, and at the top, where it showed evidence of great compression, it was changed into a material resembling mineral coal in appearance. The change was even more marked in the wooden wedge which was on the top of the prop. In this the fibrous structure was still quite apparent, but the cross-fracture was sharp and conchoidal like that of anthracite coal, the color jet black, and the luster very bright and glassy. Its specific gravity was 1.38, and its hardness the same as that of anthracite. It burned with a feeble flame, and it was thought that it might be anthracite. Analysis, however, proved that such was not the case.

An analysis of pieces of the prop and wedge, made by Mr. A. H. Sherrerd, shows as follows:

Moisture at 100° C	5.65
Volatile matter	43.05
Fixed carbon	51.00
Ash	0.30
Total	100.00

An analysis of other fragments of the same material, made by Messrs. Booth, Garrett and Blair, gave the following results:

Water at 212° F	6.793
Volatile matter	41.547
Fixed carbon	51.400
Ash	0.260
Total	100.000

This prop was imbedded in a mass of mine-refuse, slate, culm, etc., and the weight of the roof had crushed down the prop until the roof-rock rested upon the pile of refuse. At this point in the mine the fire did not get into the lower part of the "gob," but burned a little near the top. The conditions, then, which produced this alteration in the upper part of this prop were: very heavy pressure from the superincumbent mass of rock, and a smouldering heat, with exclusionof air for a period of over 30 years.

Railroads in China.

(From the *New York Herald*.)

OUR Washington advices contain two significant dispatches from the American consuls at Tien-Tsin and Newchwang, China. Mr. Bandinel, the Vice Consul at Newchwang, refers to the floods recently prevalent over the extreme northern districts of China. In some of the villages half of the dwelling places had been swept away. The deaths from starvation were numerous, and the people were reduced to eating grass grown for feeding cattle. Mr. Smithers, the Consul at Tien-Tsin, reports that a proclamation had been issued by Li Hung Chang, the Viceroy of the Northern Provinces, in which Pekin, the capital of China, is situated, directing the building of a railroad 100 miles long.

There is an essential relation between these two stories which would have made an impression years ago upon the minds of any statesmen less conservative than those who govern China. If the railroad which Li Hung Chang now contemplates had been in operation between Newchwang and Tien-Tsin there would have been no such famine as that reported by Mr. Bandinel. Food could readily have been transported from the Shanghai and other districts, where there is no such liability to floods as exists in the wide, open, frost bounds plains which sweep into Mongolia and upward toward Siberia and the North Pole. There is scarcely a spring when we have not, from Northern China, reports as distressing as those now printed by the Department of State. In the interest of humanity, therefore, it will be a gratification to know that China has ventured upon the policy outlined in the proclamation of the Viceroy Li, and that famines will not be imminent with the floods of every recurring spring. The high position of the Viceroy, the foremost subject of China in rank and authority—the Bismarck of the Empire, as it were—gives special value to his mandate.

The proposed railroad, Mr. Smithers informs the Department of State, is to connect Tien-Tsin, Taku, and Kaeping. This road will hold the same relation to the future railroad system of China as a road from Philadelphia to Cape May would hold to the present railroad system of the United States. Tien-Tsin, a city of about 800,000 inhabitants, is the commercial metropolis of Northern China and virtually the gateway to Pekin, the imperial capital, some 80 miles in the interior. Tien-Tsin is about 100 miles from the sea, at the head of navigation on the Taku River. Taku is a small collection of hamlets at the river mouth, and will be remembered as the scene of the hostilities between China and Great Britain which led to the opening of Pekin to the foreign legations. Kaeping is a coal mine, about 40 miles from Tien-Tsin, where there is already a small experimental railroad, built some years ago by the present Viceroy. The railroad proposed by Li Hung Chang will run over a low, alluvial, seaboard country, rich in agricultural resources, and probably touching the vast coal and iron deposits of the Chihli provinces. It will, however, only connect Tien-Tsin with the seaboard for the summer months, as in winter the northern provinces of China are locked in frost and ice. As it now is, after the ice sets in it takes the mails 18 days to go from Shanghai to Pekin on ponies—a distance traversed in four days when navigation is open. It will require a railroad of 800 miles to bring Tien-Tsin within all the year round seaboard communication. The nearest navigable point to insure this would be either Chefoo or Chinkiang, the Gulf of Chihli not being navigable in winter.

If Li Hung Chang succeed in building his Tien-Tsin & Taku Railroad without any interference from the gods of the winds and the waters, or various occult influences which have so often disturbed Chinese enterprise and statesmanship, we may expect a trunk line from Pekin to Shanghai along the line of the Grand Canal—say, in round numbers, about 1,000 miles. This would be equivalent to a line from Boston to Richmond. The second line would be from Shanghai to Canton, which would be like from Richmond to New Orleans. The third to Hankow—the Chicago or the St. Louis of interior China. It is quite probable that these three grand trunk lines, as the skeleton of the proposed system, are in contemplation, and that what Li Hung Chang now contemplates is but an experiment to familiarize the rulers and people of China with railways before venturing upon his greater work.

If the Viceroy is supported in his purposes and the aims of his proclamation are realized, then this news from Mr. Consul Smithers is the most important intelligence we have printed for many a day. We know of no event that can have so great a bearing upon the future of Asia, and in time, by the laws of political economy, upon that of Europe, than the opening of this vast Chinese Empire to railroads and the radical, sweeping forces of civilization

which are sure to follow. From the time of Mr. Burlingame it has been the policy of the American government, as represented by our ministers in Pekin, to urge railroads upon China. In the Burlingame Treaty special reference was made to the subject, and nothing but the traditional conservatism of the Chinese character, together with economic problems of the gravest kind, occasioned by the density of population, and the social dangers that might arise from the unavoidable interference by railroad operations with ancient and accustomed methods of transportation and industry, has prevented railroad building. In 1884, however, when China was at war with France and on the verge of a war with Japan, which the friendly advice of President Arthur did more than anything else to prevent, the Viceroy, Li Hung Chang, realized the weakness of the Empire because of the absence of a railroad system. He then communicated to the American Government his resolution to adopt railroads as soon as peace gave breathing time to China. We are glad to learn that he has held to this resolve and made a beginning.

Underground Telegraphy in England.

[Paper read before the Society of Electricians and Telegraph Engineers, London, England, by Charles T. Fleetwood.]

In the year 1816, Mr. (afterward Sir Francis) Ronalds laid his first experimental line underground, in his garden at Hammersmith, and convinced himself, at least, of the practicability of establishing telegraphic communication by means of insulated wires placed beneath the earth's surface. A small book published by him in 1823, entitled "Description of an Electric Telegraph, and of some other Electrical Apparatus," gives a full account of the experiments referred to. A trough of wood about 2 in. square, well lined inside and out with pitch, was placed in a trench 525 ft. long and 4 ft. deep; lengths of stout glass tube were joined together by means of shorter lengths of similar tube of somewhat greater diameter, the joints being made with soft wax to allow for expansion and contraction caused by the variation of temperature. A copper wire was drawn through the glass tube, and the tube was imbedded in pitch, the covering being screwed down while the pitch was hot. Mr. Ronalds further suggested that wires should be buried in iron troughs, in trenches 6 ft. deep, in the middle of the high roads, and if there was any fear of the communication being interfered with by any mischievous person or persons, two different routes should be chosen. Testing stations should be established along the route, and linemen stationed at these points ready to start out after faults at any moment, should there be a necessity for so doing. He recommended that offices should be opened all over the country, and evidently foresaw the immense advantages that would be derived by the Government, as well as by the commercial world, in the employment of what he considered so "diligent a courier" as electricity.

Messrs. Cooke and Wheatstone took out their first patent in 1837, for "Improvements in giving signals and sounding alarms in distant places, by means of electric currents transmitted through metallic circuits." In this patent they included a plan for laying down subterranean wires, and in the same year established communication between Euston Square Station and Camden Town, by means of five copper wires let into five grooves cut longitudinally in a piece of timber, the wire being covered with cotton and passed through a preparation of resin, and after being placed in the grooves, tongues of wood were placed over them to make all secure, and the whole was then covered with pitch and buried in the earth, between the above-named points.

The second patent taken out by these pioneers included placing wires, made up into cables, in iron piping; this was in 1838. During the following year a line of five wires in an iron tube was put down on the Great Western Railway from Paddington to West Drayton, and afterward on to Slough.

Conductors, covered with cotton and passed through different solutions, were tried in a variety of ways, some being suspended and others buried in pipes, but very great difficulties were experienced in preserving the dielectrics; weak places, being traced, would be repaired with India-rubber tape and a solution of the same material. This kind of work was being done near the Stepney Station, on the Blackwall Railway, when Mr. Hatcher—then Engineer to the Electric Telegraph Company—introduced to the lineman a piece of lead tubing containing several wires covered as above.

The first line of wires erected upon poles for commercial purposes, was from Nine Elms to Gosport; this was before the London & Southeastern Railway was extended from Nine Elms to Waterloo Station. The Electric Telegraph Company opened its first office at 345 Strand, and decided to lay the wires underground from that point to Nine Elms Station. Two lead tubes, about ½ in. in diameter, covered with tarred yarn, each tube containing four copper wires wrapped with two layers of thick cotton, and the tube filled with a mixture of tar, resin and grease, were drawn into a 3-in. cast-iron socket pipe. The lead tubes were originally 150 ft. in length. After the wires had been joined, a piece of lead tube of larger gauge, encircling the pipe, was drawn over the joints and soldered at each end. A portion of this tube, recently dug up, was found to be in excellent condition, the tar being quite fresh.

In the year 1843, a specimen of gutta-percha was first introduced into England by Dr. W. Montgomery, but up to 1845 only a few hundredweights had been exported from Singapore. Since that date many thousands of miles of wire have been covered and buried beneath the surface of the earth, or submerged in the sea. The quantity of gutta-percha imported into London alone during the three years ended December 31, 1886, amounted to 6,700 tons. Messrs. Keene & Nickels received a small quantity of gutta-percha from Singapore during 1845, and this appears to have been the first imported into England. This firm ultimately sold their patent for processes in working gutta-percha to the Gutta-Percha Company, Wharf Road, City Road.

During the following two years Mr. Hancock took out patents for cutting, cleansing and pressing gutta-percha through rollers; but no mention is made of covering telegraph wire in any patent up to the end of 1847.

To Professor Faraday credit has been given for having announced that gutta-percha was an excellent dielectric, and in the beginning of 1848 patents were taken out for covering wires with it. The first patent taken out in England for this purpose, so far as I can learn, was by Messrs. Barlow and Foster, the plan suggested being as follows: The wire was placed between two heated fillets of gutta-percha, and made to adhere by passing between two rollers. In the same year, Mr. John Lewis Ricardo, Chairman of the Electric Telegraph Company, patented a machine with a pair of grooved rollers, through which the wires passed, placed parallel between the fillets, the action of the rollers being to bite nearly through the gutta-percha and allow of the several wires so covered being easily separated.

These early machines did not do their work with the same regularity as those in use at the present time, for it frequently happened that instead of the covering being smooth and uniform, it was found to be thicker at intervals—so much so, that it had to be pared down with a sharp knife.

The directors of the Electric Telegraph Company, having discovered that the Strand was not the best position for their chief office in London, resolved to build a central station at the end of Founders' Court, Lothbury. This was formally opened January 1, 1848. From this office a circuitous line of 3-in. cast-iron socket pipes was laid, chiefly under the footways.

When these pipes were first laid down, wires covered with cotton, passed through one of the preparations in use prior to the introduction of gutta-percha, were drawn into the pipes; but for these wires were soon substituted the wires covered with gutta-percha.

The first section of line in London into which gutta-percha-covered wires were drawn was from Lothbury to Shoreditch, in 1849; and this was followed by the line to Euston and King's Cross. The wires that were first drawn

in were covered with gutta-percha by one of the processes already described, and failed, owing to the gutta-percha seam opening longitudinally and exposing the conductor.

At this date a large number of experiments were made; wires of iron, brass and copper were covered with gutta-percha; in some cases single wire, in others three wires, and as many as seven wires were enclosed in a solid core. Great improvements were rapidly introduced, and copper wire of No. 16 B. W. gauge was covered with solid gutta-percha of excellent quality, up to No. 1 and 3 gauge; and by August, 1854, no less than 15 miles of pipes, containing 350 miles of wire insulated with gutta-percha, had been put into working order in London alone for the Electric Telegraph Company.

The pipes used by this company were of cast-iron, 3 in. in diameter, and cast with a flat surface on one side, upon which were the initials E. T. C. Across Hyde Park the pipes were of earthenware, the joints being made with clay.

In 1850, the success of the Electric Telegraph Company induced some enterprising capitalists to form rival companies, one of which—the Submarine & European Telegraph Company—laid a line of six gutta-percha covered wires from London to Dover. This line was completed by November 1, 1852. In 1853, the British Telegraph Company commenced burying six gutta-percha covered wires along the high roads from London to Liverpool, via Birmingham and Manchester, the latter place being reached by March 1, 1854, and Liverpool during the same year.

The Magnetic Telegraph Company, in 1853, laid 10 wires as far as Liverpool, and 6 wires between Liverpool and Portpatrick. Underground wires were also laid between Cork and Queenstown.

These wires were buried in a wooden troughing of about 3 in. outside, with a groove about 1 in. square, having a lid of the same material; this was fastened down with nails after the wires had been placed in the troughing. The iron troughing was of about the same dimensions externally, but, of course, allowed more space for the wires inside; the lids were of iron.

When cast-iron pipes were used in towns, they were very similar to the iron troughing, being cast in two pieces; they were patented by both Mr. Reid and Mr. Henley, and are known as Reid's & Henley's split pipes. The wires were in some instances laid in troughing without any protection beyond the gutta-percha, but in other cases they were protected by two layers of tarred yarn laid on in opposite directions. The whole of the stores appear to have been of the very best quality.

The underground line of the Electric Telegraph Company, laid along the side of the London & Northeastern Railway, from London to Manchester and Liverpool, was somewhat different from those just described. The pipes were of earthenware, the joints being made with clay. At intervals of 150 ft. split earthenware pipes of larger diameter were fixed, to allow of the wires being drawn in. An iron wire was passed through the pipes as they were being put together, for the purpose of drawing the cables through.

From London to Watford four wires only were drawn in, but these had to be increased to eight, which number was continued on to Liverpool.

The work of constructing these different systems was finished by the beginning of 1855, and, after a very short life, in 1857–58 they were condemned, and wires on poles substituted. This applied to all the underground lines laid from London to the provinces in 1853.

When the greater portion of the wires were taken up in 1857 and 1858, a few sections were allowed to remain, especially in and near London. Portions of these lines have been recovered at different periods, in different localities, and under various circumstances. Some of the gutta-percha wires, that have been buried for more than 30 years, are now in first-class condition, but where this is the case they have been found wrapped in two layers of tarred yarn, and laid in iron casing or split pipes. The same cannot be said of that found in wood troughing, except under special surroundings. There is every reason to believe that the gutta-percha used to cover these wires was the real material, and was not subjected to anything akin to the so-called improvements in manufacture of late years.

Although the insulating material was good, yet there were many faults in the wire previous to its being buried. Probably owing to some fault in the machinery used for covering the wire, the copper wire got elongated and pressed in the form of a loop through the gum; many such places were discovered when the wires were recovered and examined.

The wire used by the Electric Telegraph Company on the London & Northwestern Railway was covered with gutta-percha, and then each wire was served with tape. After this wire was delivered on the railway at Watford, it was passed through a bath of hot tar and sand; while the drums were moving at a regular pace, a serviceable jacket of tar and sand was given to the wire, but when anything happened to interrupt the continuity of this operation the portion left in the bath was exposed to a temperature sufficient to melt the gutta-percha, and the wire passed out covered with tape, tar and sand only. Adequate care was not exercised in protecting the wire from the heat of the sun, it being allowed to remain lying on the banks of the railway uncovered for a considerable period, so that the copper wire got out of the center, and in some cases became exposed altogether. After the cables had been put in place, the drawing-in holes at every 150 ft. were left uncovered, and the ends of the wires left exposed waiting for the jointers to come and make the permanent joints, and the split couplings to be put on.

The means adopted to preserve the wires were defective. Knowledge derived from a series of observations points to the fact that split pipes, whether of wood or iron, are not equal to the requirements of a subterranean line of telegraph wires. Wood troughing is subject to dry rot, and, therefore, various expedients have been resorted to with the view of preserving the timber; but some of these preservers act injuriously upon the wire, causing the insulation to be destroyed. When the line is placed near to trees, especially oak trees, the surrounding moisture is absorbed for a considerable distance; this applies to lines constructed of either wood or split iron pipes. Special circumstances may arise that would make it expedient to use wooden troughing, but where there is an absence of such special conditions solid cast-iron pipes are to be preferred. In London, split pipes are a source of danger, for, since the chief thoroughfares have been paved with wood or asphalt, the gas that escapes in considerable quantities from the gas companies' mains accumulates under the surface and finds its way into these half-pipes, and thence into our junction boxes, causing much annoyance and inconvenience. I have known cases where the accumulation of gas, collected through split pipes, has been so great that it has been necessary to open the box some minutes before the jointer could light his lamp with safety.

Where earthenware pipes have been used instead of iron, it has been done for economical reasons only. Such a line was laid some years ago from opposite St. George's Hospital, Knightsbridge, across Hyde Park, to Tyburn Gate, the joints being made with clay. Another section of the original line laid in 1851 between the site of the exhibition of that year and the Serpentine Bridge was of earthenware. Some years ago the 16 wires that were drawn in when the line was laid, had to be drawn out to allow of the number being increased. Much difficulty was experienced in moving the old wires, and it became necessary to break one, and by laying it over the trench to trace the locality of the obstacle; when this was done, and the ground opened, it was found that the root of a tree, about 10 ft. long, had found its way through the clay with which the joints of the pipes were made, and had entwined itself around the cable in such a manner as to hold it fast. I need scarcely say that the gutta-percha had entirely perished at this point. Pipes of this description are always more liable to be damaged by the operations of the gas, water or hydraulic power companies' workmen, when opening the ground to get to their mains, than solid cast-iron pipes.

Another, and I think the chief, cause of the rapid decay of the lines referred to, was the rapidity with which the work was carried out. All the companies were racing to

get through to the provinces as soon as it was possible, and there is no doubt that this led to the work being done without the necessary supervision being given.

At the present time it is found necessary to place experienced men to watch the work as it proceeds, for where this has not been done the work has proved to have been unsatisfactorily carried out. When this is taken in connection with the fact that the majority of the men employed on these works were totally ignorant of the necessity of the greatest care being exercised, and the utter impossibility of the few able men to be everywhere along the works at the same time, it is not surprising that these early lines had to be so soon abandoned.

We now come to a very important epoch in connection with the telegraph systems of this country—the transfer of the telegraphs to the Post Office. This took place in the beginning of 1870, when all the different companies' lines were diverted to the central office of the Electric Telegraph Company in Telegraph Street, Moorgate Street. This work was carried out under the direction of Mr. Henry Eaton, now the Superintending Engineer of the Metropolitan District.

After the concentration had been effected it was soon discovered that nearly all the lines, with the exception of those in solid cast-iron socket pipes, were deficient in insulation; and, as the various methods of construction did not provide for renewals to be made without opening the ground, they were gradually abandoned, and the number of wires in the 3-in. cast-iron socket pipes of the late Electric Telegraph Company increased to meet the ever-expanding requirements of the service.

Previous to the completion of the new Post Office in 1874, the pipes and wires passing north, south, east and west of the new building were led through the basement and up to the instrument gallery, where they terminated in a very extensive test-box, the terminals being numbered from 1 to 1,000.

The change from the old office having upset all the numbers in the joint-boxes in the streets, it was considered necessary to renumber the whole, and thus make the numbers in the boxes correspond with the new test-box. This was carried out so perfectly that the whole of the circuits were diverted to the new office in a very few hours on the night of January 17, 1874, without the slightest interruption to the ordinary traffic.

At this date the length of pipes in the Metropolitan District was about 100 miles, and the total length of wire in the pipes was 3,000 miles. Shortly after this time an agitation was started against the over-house wires, and it was decided by the Post Office authorities that a new line of 3-in. cast-iron pipe should be laid down, and 100 miles of wire drawn into it, in place of 126 miles of over-house wire.

This was the first piece of work carried out in London with the view of reducing the over-house system belonging to the Post Office, and this was supplanted by others, until all the main lines of over-house wires had been removed.

The chief portion of this work was finished before the introduction of the telephone, which must be held accountable for the damages apprehended from the extraordinary network of wires suspended over the chief thoroughfares of the city, and to a lesser extent the suburbs, of London. It has had also the effect of largely increasing the mileage of underground wires, for it was soon found that, for a telephone to work well underground, two wires must be used instead of one, and after many experiments it was found that much better results were obtained by the use of four-wire twisted cable covered with tape, two of the wires being used diagonally for the telephone circuit, thereby overcoming the effects of induction. Twenty of these four-wire cables, equal to 80 conductors, are now generally drawn into one 3-in. cast-iron pipe, some of them forming part of the original lines laid down 40 years ago, in 1847; judging from what I have seen when the wires were drawn out for increasing, there is no reason to think that they are likely to give trouble for many years to come.

At the beginning of 1880, an experimental line of 1⅜-in. wrought-iron pipe and 30 No. 18 B. W. G. copper wires, each covered with manilla, and the whole made up into a cable and covered with a braid of the same material, was laid for the Post Office under the direction of the patentee, Mr. David Brooks, of Philadelphia, the insulation being obtained by filling the pipe with oil after drawing in the cable. After this line had been completed, the wires, with one or two exceptions, gave very good results as regards insulation, but from the first there was a very great loss of oil, and this continued more or less, although every effort was made to trace and repair the leaks. Although the cost of construction and maintenance has been very heavy, it appears to me that this system is worth a further trial under more favorable conditions; for instance, along a country road, where it might form part of a through line, and where the pipes would not be subject to such frequent disturbance as in the crowded streets of London.

Several very large extensions to the boundary of the Metropolitan District, and even beyond it, as well as the great increase in wires for private use, have increased the mileage from 100 miles of pipe and 3,000 miles of wire in 1874 to 240 miles of pipe and 12,000 miles of wire; an average of 50 wires through the entire length of pipes. The total weight of copper buried in the Metropolitan District amounts to over 200 tons, and that of gutta-percha to 250 tons.

In the main thoroughfares near the General Post Office the wires are very numerous. Thus, through Little Britain there are two 3-in. pipes containing 109 wires; Aldersgate, two pipes, 160 wires; Gresham Street, two pipes, 150 wires; Cannon Street, two pipes, 168 wires; Cheapside, one 4-in. and two 3-in. pipes, and 242 wires; Ludgate Hill, one 4-in., three 3-in. pipes, 350 wires; Newgate Street, two 4-in. and three 3-in. pipes, with over 400 wires.

These numbers have been reached through gradual increments, the practice being to put into a new pipe as many wires as are actually required for the special service, with a small percentage of spare wires, and as soon as these have been appropriated for new circuits, to increase the number by drawing out the existing wires and replacing them by a cable with additional conductors. This class of work is continually being carried out in different parts of London, to meet the great increase in telegraph and telephone business.

During the last 15 years nearly every section of line has been disturbed, either for the purpose of removing faults which sometimes trouble us in or near the flush-boxes, through the necessarily frequent exposure of the gutta-percha to variations of temperature caused by the linemen getting new wires through, etc., or by the necessity of increasing the number of conductors, as occasion may arise. So much of this work has been done that it would be difficult at the present time to point out any portion of line that has not been interfered with during the above period.

The advantages of being able to replace the working wires by a greater number without seriously interrupting the communication must be evident to all; but this is easily accomplished where the lines are constructed of 3-in. cast-iron socket pipes, with boxes either fixed flush with the surface or buried beneath the pavement at intervals of 150 to 300 ft. according to the size of the cable to be drawn in.

After many years' experience, and with a full knowledge of the many schemes which inventors have brought forward from time to time, I do not know of any plan which can be compared with the present system for simplicity, utility and durability.

Standard Sizes of Lumber for Freight-Cars.

THE following report was presented at the Master Car-Builders' Convention in Minneapolis by a Committee consisting of Messrs. William Forsyth, Frank J. Hecker and W. R. Davenport:

In recommending a few standard sizes of lumber for the principal members of freight-car frames, the Committee

does not expect to change existing dimensions on many of the larger roads. Its principal object is to present to the railroad public a bill of material which this Association can recommend to new roads having no adopted standard, and to other roads which are about to change from 30,000 or 40,000 lbs. capacity to a car of larger capacity. It is the hope of the Committee, therefore, that the larger roads having standard sizes which they do not intend to change will not oppose a measure which will do them no harm in the matter of car interchange, and may do others much good.

The principal advantage which railroad companies would derive from uniform sizes of car lumber is the use of dry, seasoned lumber on contract cars.

By far the largest number of freight cars are now built by contract in the individual shops. When cars are built by the railroad companies in their own shops, the lumber is taken from their own yard, where the standard sizes may be kept on hand several years, and when used it is thoroughly seasoned. With the present diversity of sizes for the frames of cars for the different roads, it is almost impossible for the contract shops to keep in stock such a variety of lumber as will suit any order they may get. The result is that in most cases the lumber is not bought until the order is secured for cars, and it frequently happens that it is not *sawed* until that time.

It is not an uncommon practice to build cars from lumber which a month before was in the mill-pond in the form of logs.

The evil effect of this practice is well known to car-builders, and it is undoubtedly the worst feature of contract cars. As the lumber dries and shrinks in the car the whole frame becomes loose, and the life of the car is materially reduced not only by the working of loose joints, but by the premature decay of the lumber itself, when it is put together and painted before it is dry.

It is a well-known fact also that kiln-dried lumber is not as strong as seasoned lumber, and it will rot quicker.

If standard sizes were adopted, the contract shops could keep on hand a sufficient stock of lumber to allow it to season one or two years, and the railroads could then obtain by contract a much better car than they usually do.

It is possible to specify a certain maximum amount of moisture in car lumber, and to obtain lumber to such specification, by measuring the amount of moisture in sample borings.

The borings from about a cubic foot of wood are placed on a vial and weighed on a chemist's balance; they are then evaporated to dryness and weighed again, the per cent. of loss noted representing the water driven off. In this way the fluctuation of moisture during the process of seasoning has been obtained for oak, ash and pine, and it is shown in the diagram which accompanies this report.

Green oak as received in the yard contains 45 to 50 per cent. water, and after a year's seasoning it still contains over 30 per cent. Norway pine from the mills contains over 25 per cent. water, and a year's seasoning reduces it to 10 or 12 per cent. Pine should be seasoned at least one year, and oak two years to avoid excessive shrinkage and early decay. The amount of water in lumber may be taken as a direct measure of the length of time it has seasoned.

The majority of cars now building are 34 ft. long, so that one dimension of the long sills may be regarded as settled for the time. New equipment is also largely centering about a capacity of 50,000 lbs., and we recommend sizes suitable for that capacity. These sizes are not extra large for cars of 40,000 lbs. capacity, and they are sufficient for one of 60,000 lbs. The additional strength required for the latter can easily be obtained by the use of a deeper truss made of iron of larger diameter.

We, therefore, recommend the following bill of lumber for principal members of car body for 34 ft. box, stock and flat cars, capacities 40,000 lbs., 50,000 lbs. and 60,000 lbs.:

Under Frame:

Six long sills, 5 × 9 in., finished Norway pine.
Two end sills, 7 × 9 in., finished oak.
Two cross ties, 4 × 9 in., finished oak.
Four draw timbers, 4½ × 7½ in., oak.
Flooring, 1¼ in. thick, 5 to 10 in. wide, Norway pine.

Upper Frame:

For the same cars as above, excepting flat cars:
Eight door and corner posts, 4 × 4½ in., finished oak.
Twenty-four pieces, intermediate posts and braces, 4 × 3 in., finished oak.
Two end plates, 3 × 12 in., finished oak.
Ten carlines, 1¾ × 9 in., finished oak.
Two side plates, 3 × 7 in., finished Norway pine.

We recommend also that the above sizes be submitted to the Association for approval by letter ballot, as standards for freight-car lumber.

Robert Hale's Machines for Cutting and Bending Metal Bars.

AMONG the visitors at the convention of the Master Car-Builders' Association, held in Minneapolis in June, was the venerable Robert Hale, who for a number of years was the General Superintendent of the Chicago & Alton Railroad and who before that time occupied responsible positions on other roads. He is now Secretary of the Board of Trade in Minneapolis, but like all ex-railroad officers, he is still enterested in the profession of his earlier years.

Mr. Hale is the inventor and patentee of a machine for cutting and bending metal bars, such as truck-frames, coupling-links, etc., and several other devices to be used on railroads, including a safety car-heater. With reference thereto Mr. Hale writes as follows:

I inclose with this one copy of the work explanatory of the machine for shaping by pressure, straightening, etc. The work explains the merits claimed. Also official printed copies of the letters-patent covering the improvements (dated June 16, 1874, Aug. 28, 1877, Nov. 20, 1877). In addition, at the end of the book is attached a circular issued by me 10 years ago for an improvement in car-heaters, which was patented immediately after the Ashtabula accident, when so many lives were lost by the fall and the burning of the cars, as has been too frequently repeated in the past year or two. The improvements in the machine are covered by three letters-patent and the heater by one—four in all.

As a piece of professional liberality on my part, having devoted 35 years of my early business life to the management of railroads, in all the different departments of service, from the lowest to the highest, and having been intimately acquainted with most of the earlier generation (now nearly gone) of railroad officials and managers, and desiring to aid (even in a small degree) those engaged in the profession, and the interests they are so devotedly serving, I assigned the right (or donated the right) to the following roads, and will donate the same to any other roads that may desire to use the improvements.

The assignments (as per copy inclosed) give the right to any and all roads to *build* and use, but not to *build* or *sell*, neither to purchase of outside parties who have *not* obtained the *right* to *build*, as there are now parties who are infringing these patents at their peril.

The saving of expense to railroads by the use of these machines would in the aggregate be a large sum—but to me *personally* nothing. * * * * ROB'T HALE.

P S.—I will add that the patents for the machine were examined by the Secretary and Attorney of the Western Railroad Association, who reported that they did not infringe any patents previously granted and that they were *valid* patents.

R. H.

Assignments of R. Hale's Patents for Bending Machinery, etc., made to the following railroads—donated:

JANUARY 2, 1882.

1. Chicago, Milwaukee & St. Paul (4 patents) '79.
2. Chicago & Alton.
3. Illinois Central.
4. Chicago & Northwestern.
5. Chicago, Rock Island & Pacific.
6. Chicago Burlington & Quincy.
7. Michigan Central.
8. Lake Shore & Michigan Southern.
9. Northern Pacific.
10. Wabash, St. Louis & Pacific.
11. St. Paul, Minneapolis & Manitoba.
12. Chicago, St. Paul, Minneapolis & Omaha.
13. Pennsylvania, and leased lines.
14. New York Central & Hudson River.
15. New York, Lake Erie & Western.

JANUARY 5.

16. Atchison, Topeka & Santa Fé.
17. Central Pacific.
18. Union Pacific.
19. Baltimore & Ohio.
20. Boston & Albany.
21. Eastern.
22. Boston & Maine.
23. Old Colony.
24. Boston & Providence.
25. Boston & Lowell.
26. Concord, and Manchester & Lawrence.
27. Northern (New Hampshire).
28. Central Vermont.
29. New York & New England.

Late English Torpedo Experiments.

SOME interesting experiments made in torpedo attack and defence by the English Navy, recently, are described by the London *Times*, whose account is given below. The vessel was the old iron-clad *Resistance*, and the experiments were made in Fareham Creek, near Portsmouth.

As the machinery was not in use and there was no steam in the boilers, the effect of the jar upon the steam-pipes, glands and feed connections will remain a matter of speculation. So far as the consequences of the burst upon the structure of the hull itself is concerned, every care has been taken to make the ordeal as complete and instructive as possible. The wing passage, which has a *maximum* diameter of 3 ft., diminishing to a point, is left empty, although at the former experiments the lower portions were filled with coal. But behind this, and at a distance of 8 ft. from the wing bulkhead, a longitudinal or fore-and-aft steel bulkhead ⅜ in. thick, has been worked to a length of 61 ft., and, with the coal with which the intervening compartment is packed, forms (as in recent armor-clads) a solid rampart 20 ft. high, for the defense of the engine-room. The height of the double bottom between the outer and inner skin plating is 2½ ft. The watertight compartments are divided into stations by means of vertical lightening plates pierced by three holes, and in order to make them, as far as was practicable, resemble the bracket frames of a modern armor-clad, the center of the plates was cut away so as to leave a single oval hole instead of the three circular holes previously referred to. So far no objection can be taken to the means adopted to test the actual effects of a torpedo exploding against the unarmored parts of a ship-of-war. But in extending and strengthening the under-water protection of the *Resistance*, the practical value of the experiments is discounted. As is well-known, Sir Edward Reed has suggested a means of meeting the attack of the ram and the torpedo by armor-plating the inner bottom. As to this device, Sir Nathaniel Barnaby has expressed his want of faith in its utility for the Navy after having seen the plan worked out by Sir Edward Reed. The ex-Director of Naval Construction was of opinion that the true defense for us against the increasing power of the under-water attack lay in numbers of ships. In view of the difference of opinion which exists on the part of experts on the subject of under-water protection, the officers of the *Vernon* determined to submit the problem to the test of experiment. For this purpose steel armor 1½ in. thick has been worked along the outside of the upper skin of the double bottom throughout one of the compartments, in addition to the other protection mentioned. But however desirable it might be to practically determine the value of Sir Edward Reed's suggestion, it is evident that it ought not to be subjected to experiment until the resisting power of the other defenses had been ascertained. We have no ships protected against under-water attack by armor-plating, and hence, by combining armor with the ordinary protection, the present demonstration as a test of the worth of the existing under-water structures on board ship loses much of its significance.

The *Resistance* has been brought down by iron ballast to a trim of 25 ft. 9 in. aft and 19 ft. 7 in. forward, giving a mean draught of 22 ft. 8 in. She is, consequently, rather further down by the stern than before, but is in other respects the same. When in commission the *Resistance* had a mean draught of 26 ft. 10 in. But however desirable it might have been to immerse her to her original load line, the thing was rendered impracticable from the want of water in the creek. The present series of experiments promises to be of even greater importance than the first series. The attack will be gradually developed by means of fixed and outrigger charges of increasing power, and the *coup de grace* will not be given by means of a service Whitehead torpedo in actual contact until various lessons have been derived. The opening experiments yesterday consisted of an attack directed against a new system of torpedo defense, which are to be carried by ships in action, or when in expectation of an attack, rather than an assault upon the ship itself. The previous experiments had clearly demonstrated that a Whitehead, when projected against a vessel at close range, and consequently with a *maximum* of motive force, could not get through the ordinary wire netting before expending its explosive energy in the air, and that the spars by which the nets are boomed out from the ship's side could be reduced to 25 ft. in length without danger to the hull. The ordinary wooden booms employed on board ship, however, are heavy and unwieldy, weighing as they do more than half a ton each. In ordinary circumstances the spars cannot be lowered into place and the nets made taut in less than a couple of hours, and the work of stowing them is equally slow and laborious. Mr. Bullevant, who manufactures the torpedo netting and hawsers for the Navy, has devised a method of getting rid of the difficulties complained of by substituting steel booms for the wooden booms and an arrangement of pulleys and runners, whereby the protection can be run out and in, topped and brailed up out of the way, with great facility. The system was tried at Portsmouth last year with considerable success upon the *Dido*, but as it was thought that some of the fittings were somewhat frail and might collapse beneath the shock of a live torpedo it was resolved to submit them to a practical test under service conditions upon the *Resistance*. The ship was consequently fitted with three of the steel booms on the port side. They were 32 ft. long and spaced 45 ft. apart, and connected by a jackstay to which the nets were attached. Each steel boom weighed 5 cwt., or less than half the weight of the ordinary boom, and whereas the latter is fixed to the ship's side by a hook which is liable to be disconnected or broken by the jerk of an exploding torpedo. Mr. Bullevant's boom works in a universal or socket joint, which cannot get out of gear except by fracture, and which permits the boom to be moved in any direction, whether vertically or fore and aft, close in against the sides. Below each boom is a flange, which serves as a line along which a traveler moves, the latter being actuated by means of a topping line running over a pulley at the head and another near the heel. Upon the booms being topped to a perpendicular position the nets are attached to the runners at the bottoms of the booms close inboard (instead of under the existing system to the tops of the booms from the boats alongside or otherwise), and when this is done the mere depression of the booms into position will cause the nets to run out of their own accord. In like manner, when the occasion for their use has passed, the rising of the boom will cause the nets to come alongside, when they can either be brailed up through the grummets or disconnected for future use. The action of the gear is so simple and rapid that the torpedo protection can be always ready without arresting the way of the ship. As a length of net 30 ft. by 20 ft. deep weighs about 30 cwt., it will also be seen that the reduction of strains by working the crinolines from the heel instead of the head of the boom is considerable.

The attack by the Whitehead upon the booms and nettings was made shortly before 2 o'clock, June 9, at the time of high tide. The proceedings were understood to be of a strictly confidential character, but facilities were granted to the dockyard officers and also to the naval and military officers belonging to the port and garrison to witness them, although no measures were taken to inform

them as to the nature and value of the experiments. The whole affair occupied a very few minutes. As soon as the red pennant was stuck on board to show that Mr. Bullevant was satisfied with the arrangements and that the target was ready, the antiquated torpedo vessel *Vesuvius* got under way, and, after circling around the doomed hulk, discharged a Whitehead against the netting from her under-water low torpedo tube at an approximate range of 50 yards. As on former occasions, the missile was one of the old 16-in. pattern, but it was understood that the charge of gun-cotton had been reduced to 87 lbs., so that the net protection should not bear a greater strain than would be the case in actual hostilities. The torpedo, which was set to a depth of about 10 ft., struck the net in the middle and threw up an immense spout of water, but without getting to the ship, which was apparently uninjured. Although it hit the net immediately below the center-boom, no fracture occurred, and the points remained intact. It may also be mentioned that, although at the short range the torpedo would spin through the water at from 30 to 40 horse-power, and would deliver a formidable blow upon the net, the thrust was effectually resisted, though as a matter of course the net was much torn by the explosion of the baffled projectile.

The second torpedo attack upon the *Resistance* was made June 10, and, although the offensive power that was brought to bear was quite exceptional, the victory so far remains with the ship. So unquestionably is this the case that the shipbuilding department are naturally elated, and even go so far as to doubt whether the torpedo officers will be able to destroy the old ship by any legitimate or other means susceptible of practical application in time of war. The hulk is perfectly motionless. The enemy can deliver his attack without interference on the part of the attacked, he can execute his operations in his own time, he can employ his most expert and capable torpedoists (professors of the art, in fact), he can use whatever charges he likes, and can place them just where he thinks they will do the most mischief. Nor must it be forgotten that the target in this instance is not a fresh one. It has been tattered and torn by previous conflicts with submarine enemies, and has had its honored scars plastered over on the inside by planking and other surgical artifices, and yet, with all these great advantages in favor of the attack, the *Resistance* continues not only afloat, but is to all appearance as tight as a bottle, with the exception that a few trivial runlets have managed to find a passage in the region of the old sores. The charge exploded yesterday was an exceptionally heavy one. It consisted of 220 lbs. of gun cotton. It was consequently more destructive than any which is ever likely to be launched against an armor-clad much better prepared to resist it than the obsolete and time-worn *Resistance.*

Mr. Bullevant's patent booms and runners, which were found to be scarcely anything the worse from the ordeal of the previous day, were again used. The damaged net was taken away, and one of the old service grummet nets slung in its place, the cylinders containing the gun cotton being attached to the jackstay immediately in front of the battered sides and 30 ft. from the hulk, and sunk to a distance of 20 ft. below the water-line, which would bring it about opposite the bend of the bilge. By 3 o'clock, or half an hour after the time fixed, everything was ready for the explosion of the charge, everybody had cleared out of the ship, while the surrounding small craft drew off to a distance of 300 ft. The charge was electrically fired from a pinnace. The burst was terrific, and the reverberation was heard and the shock distinctly felt in the dockyard. But the remarkable thing was that the hulk did not appear to jump in the least, although there was not more than 6 ft. of water under her keel. That she would not be seriously crippled by the discharge seems to have been accepted as a foregone conclusion by Captain Long and the other torpedoists, as the day for the third experiment had been fixed in advance, but that the steel booms, with their double-flange running ways, stays, travelers and hinges, should have resisted the tremendous jar and upheaval was a genuine surprise for all concerned, and goes far to prove that, except a vessel be taken unaware, it will be impossible for a torpedo to come into actual contact with it. At the experiments last year, the wooden booms were unhinged and splintered under a much less violent shock than that of yesterday. But the steel booms employed, though somewhat bent, remained unbroken and in position, and the joints were quite uninjured. All that is necessary for perfect defense is that the booms should be made a little heavier.

At the third trial, June 13, the torpedo operators attacking the *Resistance* exploded 95 lbs. of gun cotton 20 ft. below the water and in contact with her double bottom. This amount of explosive represents the full charge of the old pattern 16-in. Whiteheads, but as the hulk was, for prudential reasons, moored close to a mud-bank, and as the water was consequently much too shallow to allow of a locomotive torpedo being set to run at the required depth, a fixed charge was lashed fore and aft against the bottom plating of the ship and electrically exploded from No. 95 torpedo boat.

In previous experiments this year, the ironclad was attacked on the port side, which had been specially strengthened for the occasion, and the result, as we have pointed out, was a victory for the defense. This time the starboard side was selected for attack, in order that a comparison might be instituted with the effects produced under different conditions by a similar experiment. Last year, in the latter case, the double bottom was filled with coal; this year, the double bottom, which is about 2½ ft. deep, was kept empty and the torpedo placed in immediate contact with it, in such a manner that, being overhung by the contour of the hull, the ship would feel the full force of the upward, as well as the lateral, energy of the charge. The importance of the experiment was obvious, for, although it had been ascertained that torpedo nets were capable of protecting a battle-ship from the bursts of the heaviest locomotive and outrigger charges, it might happen, of course, that the nets would be rent or displaced by shell fire or swept away by a grazing ram or even attacked by a double torpedo, the second passing through the gashes made by the explosion of the first in any case.

It was of urgent necessity that the effect of a torpedo bursting in immediate contact with a ship's bottom should be practically and clearly determined. The charge was fired just before 5 o'clock, in the wake of the boilers, and it was soon perceived that something of a fatal character had taken place, from the appearance of coal dust sweeping up through the hold. The report had not the dull boom to which the spectators had become accustomed. Instead of this, the gun cotton exploded with a sharp, angry, whistling noise, while the manner in which the mud was churned up showed that the force of the rebound was terrific. The ship lifted bodily near the stern, after which it was seen to leisurely heel over to starboard some eight or ten degrees, and finally repose, though not until the tide fell, upon the mud. The old hulk had been mortally wounded at last. A complete knowledge of the disaster which has overtaken her will not be obtained until a careful investigation has been made of the hull in dock. But, from a hasty exploration which was conducted on board, it was evident that the shot had not only dislocated the inner plating of the double bottom, but had penetrated the bunker compartment, stored as it was with coal, that the water-tight doors and compartments had ceased to operate, and that water was flowing into the hull through a hundred crevices. To such an extent was this the case, that, though a strong working party was at hand, ready for any emergency, it was deemed useless to attempt to free the ship of water until her gashes had been temporarily closed from outside. When this has been done, she will be pumped out and brought into dock for careful examination. From what has been said, it will be seen that, while the explosion of 95 lbs. of gun cotton in actual contact, last November, simply crippled the *Resistance*, the explosion of a like charge, at the same spot and under approximately the same conditions, has in this instance, not simply disabled, but really sunk the ship.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Concluded from page 331.)

CHAPTER V.

THE RUNNING GEAR.

TRUCKS.

When trucks were first used in this country, it was considered very essential that their axles should be as near together as possible, and from figs. 12 to 22 (pages 43–46, January number) it will be seen that the trucks of all the early engines built at the Rogers Works had their wheels as close to each other as they could be placed. With outside cylinders this could be done without difficulty so long as the cylinders were inclined, but owing to the rolling motion which was produced by cylinders, with a steep inclination and also other inconveniences, the tendency was to lower the cylinders, and, excepting with large driving-wheels, this made it necessary to spread the truck-wheels farther apart. Finally, the cylinders were brought down horizontal, and it was then found that there was really no disadvantage in placing the wheels the required distance apart, but rather the reverse.

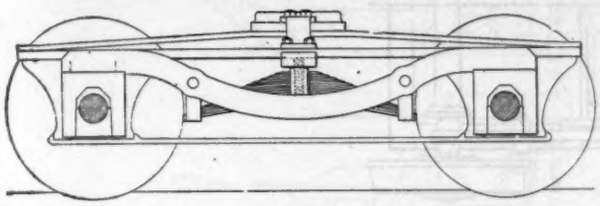


Fig. 204.—1850.

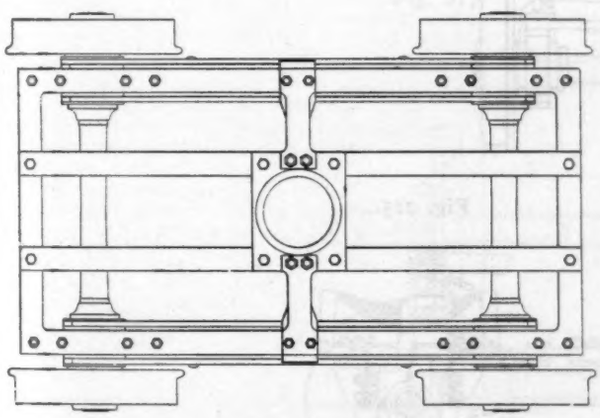


Fig. 205.

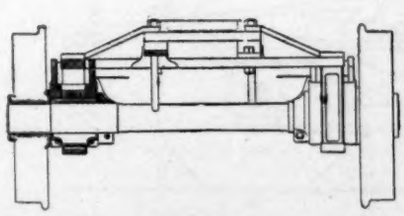


Fig. 206.

Excepting as they are shown in the small engravings of the engines, no drawings of the early trucks which were made at the Rogers Works have survived to the present time.

In 1850, Mr. Rogers designed the truck shown by figs. 204, 205 and 206. This had a rectangular wrought-iron frame with either cast or wrought-iron pedestals bolted to it, and with a pair of bent equalizing levers on each side and a spring between the wheels, as shown. The center-plate was carried on a system of bracing, clearly shown in the engravings. This form of truck has been built continuously ever since it was first introduced, with very little change, and has been adopted by other locomotive builders substantially as it was designed by Mr. Rogers, and probably is more extensively used, and has given greater satisfaction than any other form of locomotive truck that has ever been made. It is still the standard locomotive truck on many railroads.

Figs. 207, 208 and 209 represent a truck introduced in 1852. This had journal bearings both inside and outside of the wheels. It was used for fast passenger engines, and is shown in fig. 23 (page 46). It was first made with a center bearing, but later the Bissell arrangement, which is shown in the engravings, was combined with it.

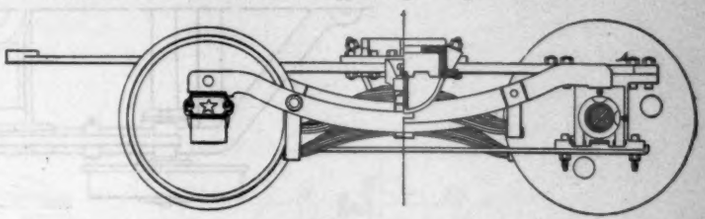


Fig. 207.

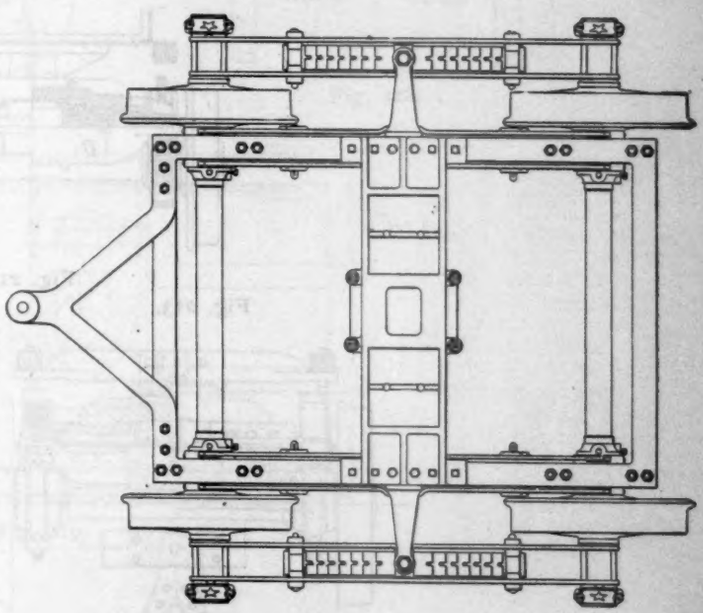


Fig. 208.

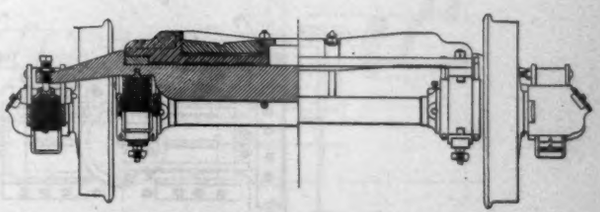


Fig. 209.

In 1857, Mr. Bissell patented the truck which ever since has been known by his name. His first patent was for a four-wheeled truck, shown by figs. 210, 211 and 212. The frame of this truck was extended backward, and instead of turning around a center-pin between the two axles, the pin *C* was placed some distance behind the rear axle, and the truck turned or vibrated around it. The engine rested on a pair of V-shaped inclined planes, midway between the two axles. One of these inclined planes is shown in section at *D* in fig. 212.

The inventor claimed that a truck of his plan adjusts itself to the curvature of the track better than one of the ordinary plan. Mr. Hudson was one of the first to recognize the value of Bissell's invention, and applied it to a locomotive in 1858. In the same year Bissell patented the single axle or "pony" truck as it is often called. This was constructed on substantially the same principle as his four-wheeled truck, and is represented in figs. 213, 214 and 215 In the engraving, fig. 214, to save room, the extension of the frame, which is attached to the center-pin, is represented as being broken. This truck was applied to some Mogul engines at the Rogers Works in 1863.

In 1862, Mr. Alba F. Smith patented "the employment in a locomotive engine of a truck or pilot fitted with pendant links to allow of lateral motion to the engine." Smith's invention consisted in the substitution of swing links for the inclined planes in Bissell's truck. Smith's truck is shown in figs. 216, 217 and 218. The engine rested on a bolster, *B*, which was suspended from the truck by swing-links *L L*, figs. 216, 217 and 218. From these it received the name of the swing-motion truck. It was first applied to a locomotive at the Rogers Works in 1865.

In 1864, Mr. Hudson took out another patent for an improvement in lateral moving trucks, which is shown in figs. 219, 220 and 221. Instead of pivoting the trucks to a fixed

Fig. 210.

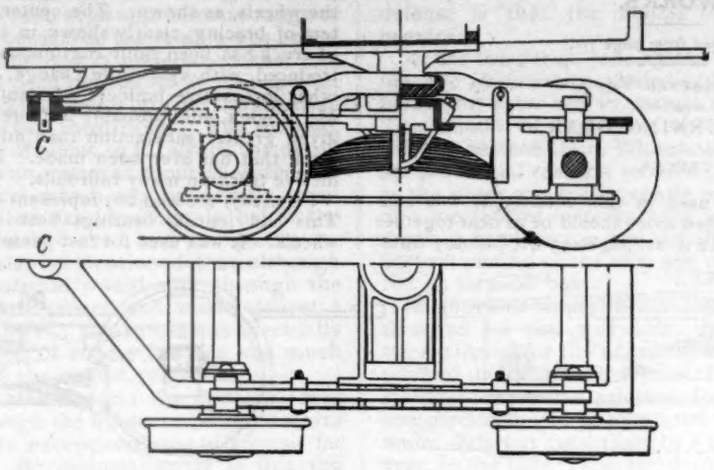


Fig. 211.

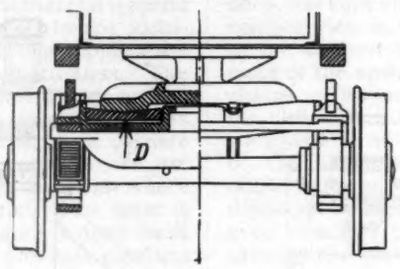


Fig. 212.

Fig. 213.

Fig. 215.

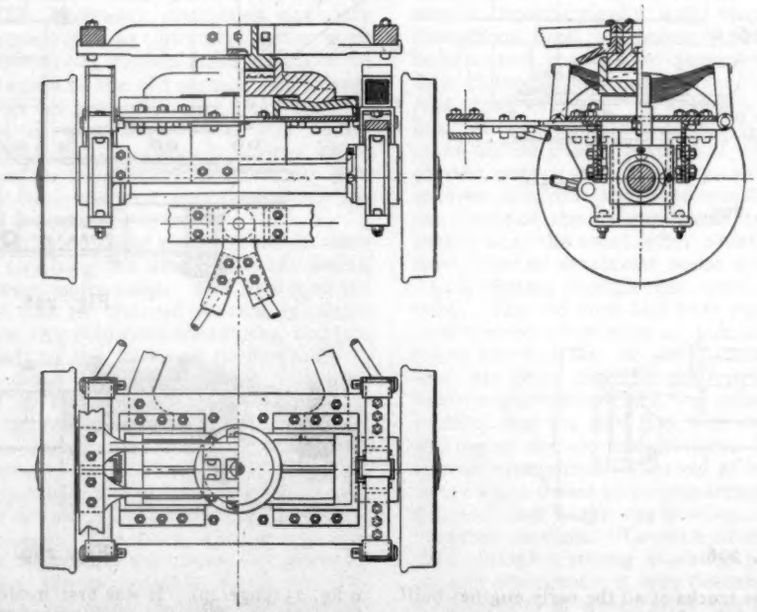


Fig. 214.

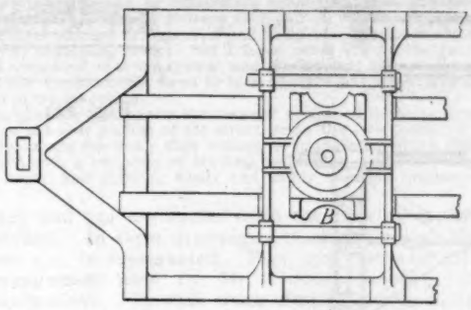
point behind the axles at *A*, as Bissell did, Mr. Hudson used a long link or "radius bar," *B B*, which was pivoted at its front end *C* to a pair of lugs attached to the center-pin plate of the engine. The back end of the radius bar was allowed some lateral motion, but was confined within certain limits by a sort of guide shown at *D*. This arrangement, Mr. Hudson claimed, permitted the truck to adjust itself more perfectly to curves of different radii than was possible without the use of the radius bar. The arrangement was used with both Bissell's and Smith's lateral motion mechanism.

The most important results accomplished by Bissell's invention were due to the adoption of his lateral moving single axle or "pony" truck, as it is called, which was pivoted behind the axle. The first engine of the "Mogul" type, fig. 26 (page 46), which was built at the Rogers Works, had a two-wheeled Bissell truck with the inclined planes for producing the lateral motion. It was completed in 1863. Afterward, the swing-links patented by Mr. Smith were used.

In the description of the engine illustrated by fig. 17 (page 45), it was pointed out that it had equalizing levers, which extended from the driving-axle to the center of the truck on each side of the engine, with springs in the center of the levers. Although this arrangement did not give satisfaction at that time, it had the germ of an invention which Mr. Hudson afterward applied very extensively.

In 1864, he patented the arrangement, shown by figs. 222, 223 and 224, of an equalizing lever between the two-wheeled truck and the front driving-wheels, whereby both the truck and driving-wheels maintain their proper portion of weight and accommodate themselves to the vertical, as well as to the lateral, motion required to enable the engine to pass over uneven tracks and around curves with ease as well as with safety. In the arrangement referred to the driving-wheels *E* and *F* each have the usual springs *e* and *f* connected together by an equalizing lever *I*, with a fulcrum at *i*. The driving-wheels *G* have springs *g*. The front strap or hangers *n* of these springs are connected to a cross-beam, *J* (shown clearly in fig. 223). A central equalizing lever, *K*, bears on the middle of the

Fig. 216.



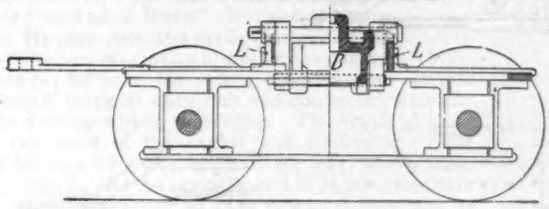


Fig. 217.

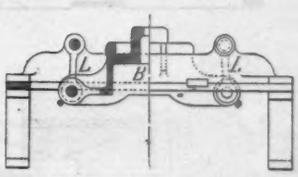


Fig. 218.

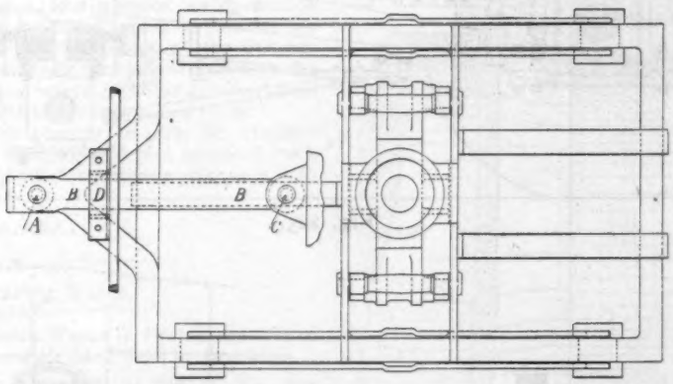


Fig. 219.

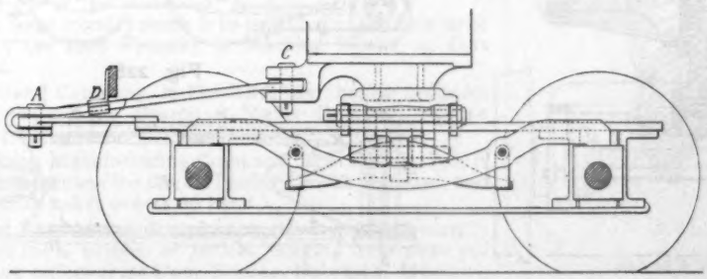


Fig. 220.

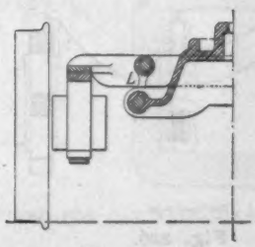


Fig. 221.

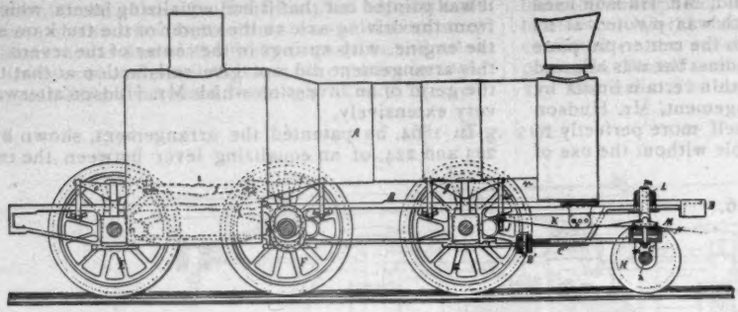


Fig. 222.

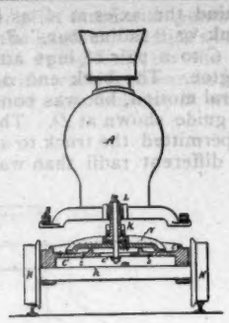


Fig. 224.

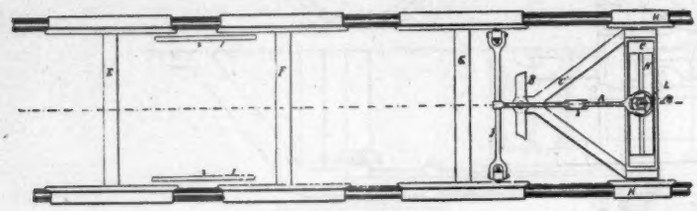


Fig. 223.

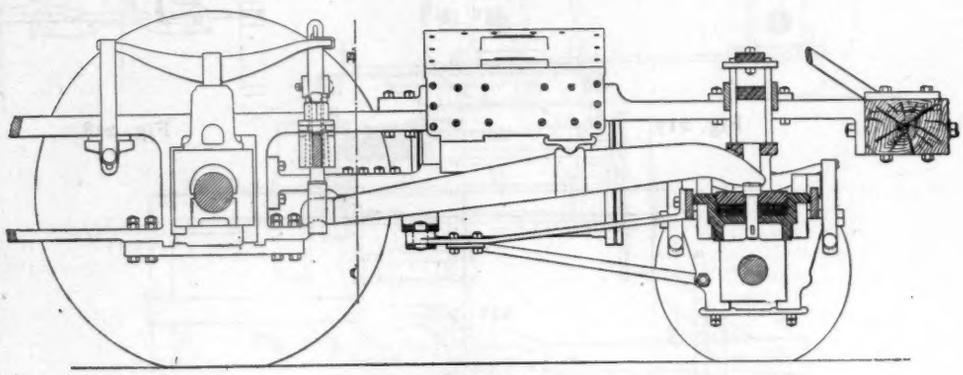


Fig. 225.

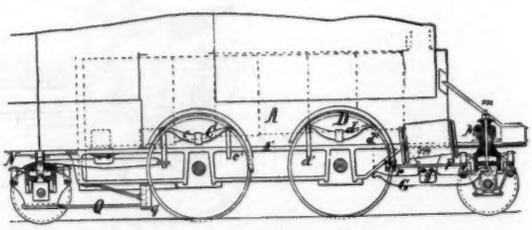


Fig. 228.

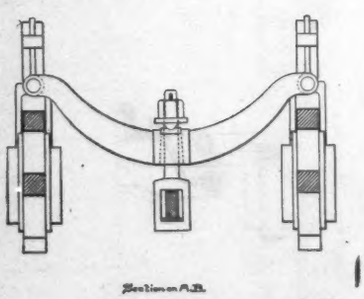


Fig. 226.

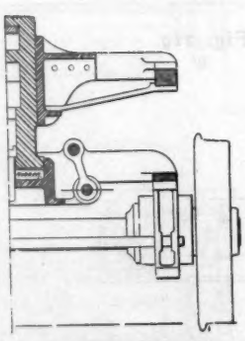


Fig. 227.

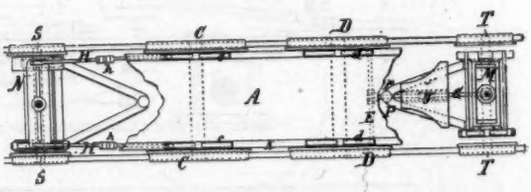


Fig. 229.

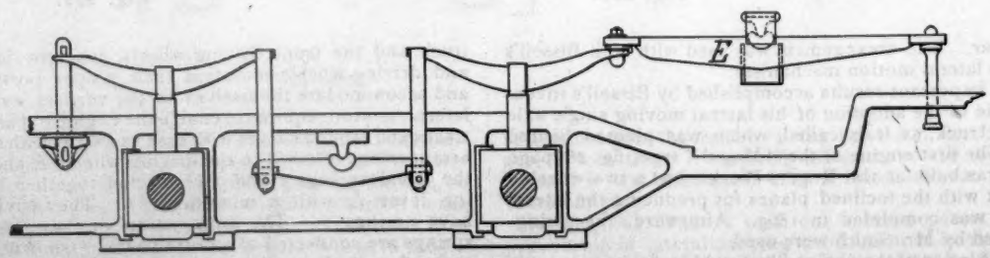


Fig. 230.

cross-beam *J*. It has a fulcrum at *k*, and its front end rests on the bolster or swing-beam *N* of the truck. The effect of this arrangement is that any weight borne by the driving-wheels is transmitted to the truck and *vice versa*. In his patent specification Mr. Hudson said:

"If tracks could be made perfectly uniform and regular and be maintained in that condition, my invention would be of little importance; but in practice irregularities more or less serious occur at nearly every joint or junction of the ends of the rails, and at certain points in the track, as in passing switches and across tracks, and especially in passing over small obstacles or defects in the road, the inequality in the load which is thrown upon the several wheels becomes immense; unless, in addition to the use of the springs, provision is made, by introducing equalizing levers in some manner, to induce a unity of action between each pair of wheels and some other pair. The three pairs of drivers, *E*, *F* and *G*, fig. 222, have been connected together by equalizing levers: but I have never known the two pairs *E F* to be connected into one system, and the forward drivers *G* to be connected to the truck-wheels, so as to form another and independent system, previous to my invention.

"My invention practically supports the forward portion of the structure at the point *k*, and the rear portion of the structure on the two points *i i*, opposite the sides of the fire-box; thus making a triangle on which the structure is carried with a certainty of holding each wheel with sufficient force upon the track, and yielding easily and safely to every ordinary inequality."

Figs. 222, 223 and 224 are copied from the drawing of the patent specification. In these drawings a truck, with Bissell's inclined planes *c c*, is represented. Figs. 225, 226 and 227 show the arrangement used by Mr. Hudson in 1865 for "Mogul" locomotives. In this truck Smith's swing-links were substituted instead of Bissell's inclined planes.

In 1867, Mr. Hudson patented his double-end truck locomotive, to which reference was made in a previous chapter. Figs. 228 and 229 are copied from his patent specification. In this engine the Bissell truck at each end was connected with the springs of the driving-wheels adjoining. The truck of what is ordinarily the front of the engine was connected to the driving-wheel springs by a single equalizing lever in the manner already described. At the opposite end of the engine there were two equalizing levers, one on each side of the fire-box, as shown in the engraving.

In 1872, Mr. Hudson patented another form of double-end truck locomotive. This had a four-wheeled swing-motion truck behind the fire-box, and a "pony" truck in front of the cylinders. Fig. 230 shows the arrangement of the driving-wheel springs and the way that they were connected with the "pony" truck by the equalizing levers *E*. The driving-wheel springs were not connected with the four-wheeled truck.

As was stated in a previous chapter, in 1872, Mr. Hudson took out a number of patents covering different forms of truck locomotives to which his method of equalizing the truck with the driving-wheels was applied.

(*Concluded.*)

Manufacturing Notes.

THE Rhode Island Locomotive Works in Providence, are to build 45 locomotives for the new elevated lines in Brooklyn.

THE Sharon Steel Casting Company, at Sharon, Pa., has just completed an extensive plant for making steel castings of all sizes.

ANOTHER large foundry room is to be added to the now large foundries of the Bass Foundry & Machine Works, at Fort Wayne, Ind.

THE Portland Company, in Portland, Me., has an order for 20 locomotives for the Boston & Maine Railroad. These works now employ about 350 men.

THE Dickson Manufacturing Company, at Scranton, Pa., is building 9 locomotives for the St. Paul & Duluth Railroad, and has a number of other orders on hand.

THE Pond Engineering Company, in St. Louis, has recently taken orders for a number of boilers, ranging from 50 to 100 H. P. These orders come from Kansas, Nebraska, Missouri, Arkansas and Texas.

THE Harlan & Hollingsworth Company at Wilmington, Del., on June 16, launched the steamer *Parthian*, 246 ft. long, 38 ft. beam and 26 ft. depth of hold. The *Parthian* is intended to run between Boston and Philadelphia.

AT the Columbian Iron Works at Locust Point, Baltimore, the keels have been laid for two new steel ferry boats for the Staten Island Rapid Transit Company. The steel for the new gunboat No. 2, for the U. S. Navy, is now being received at these works.

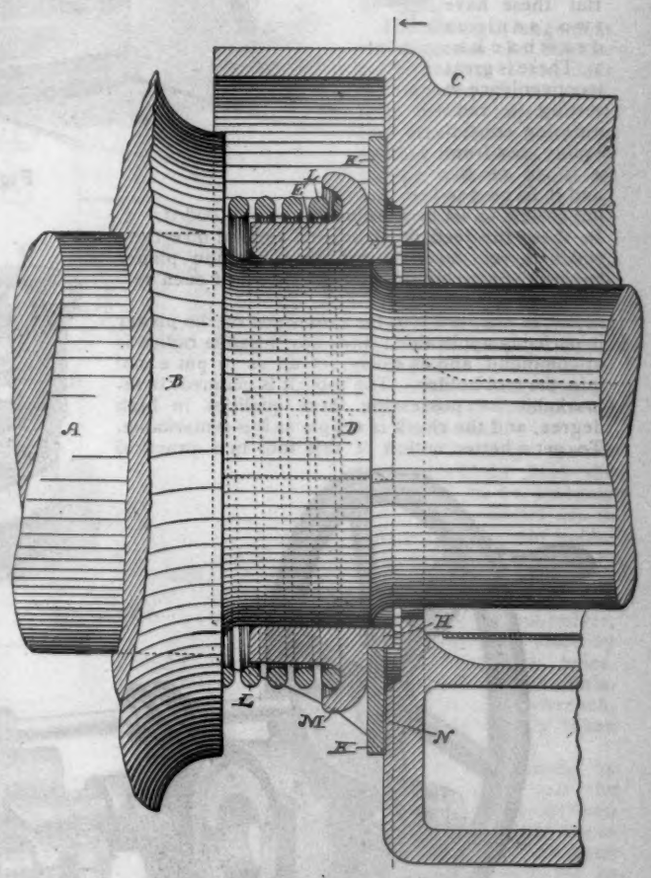
THE Pennsylvania Steel Company is about to build two blast furnaces of 200 tons daily capacity, at Sparrow Point, near Baltimore, Md., where it recently purchased a tract of 100 acres of land. It is said that a rolling mill will also be built, and other portions of the works, now at Steelton, will be hereafter removed to the new location. The company recently ordered 16 boilers of 240 H. P. each, from the Babcock & Wilcox Company, for the new furnaces.

THE Old Colony Railroad shops in Boston are building three new passenger engines with 17 × 24 in. cylinders, from the designs of Mr. James V. Lauder, the Superintendent of Motive Power. Engines of this class now in use take trains of 14 and 15 cars at high speed. The steamboat train on this road now makes the run of 51 miles between Boston and Fall River without stopping, the engine being provided with a special tender carrying 3,500 gallons of water.

Dust Guard for Car Axle-Boxes.

THE engraving shows a form of dust-guard which has been patented by Mr. W. S. G. Baker, President of the Baltimore Car Wheel Company, which he describes as follows:

"*A* indicates a car-axle, *B* a section of a car-wheel, and *C* a car-axle box, which parts may be of any ordinary construction. Around that part *D* of the axle known as the "dust-collar" I place a metallic sleeve' *E*, preferably formed with a feather, on its inner side, which fits in a longitudinal groove or keyway in the dust-collar of the axle, so that the sleeve, while keyed to the axle so as to revolve with it, is free to move longitudinally upon it.



BAKER'S DUST GUARD FOR CAR AXLE-BOXES.

The face of the sleeve next to the axle-box is provided with an annular projection, having lugs for the purpose of securing a suitable washer, *K*, which may be of vulcanized fiber or other suitable material, in place, and causing it to revolve with the axle and sleeve.

L indicates a coiled spring around the outside of the sleeve *E*, bearing at one end upon a ledge or projection, *M*, which is a part of the sleeve, and at the other end against the car-wheel. This spring forms a cushion between the sleeve *E* and the car-wheel, and causes the sleeve to press against the washer *C* and cause it to bear upon the end of the axle-box, so as to make a tight joint and exclude dust from the box and prevent the oil from escaping.

The patent is dated April 19, 1887, and numbered 361,255.

Special Tools for Railroad Repair Shops.

(*Continued from page 280.*)

THE late W. W. Evans, the eminent engineer, wrote, not long before his death: "Portable tools are very useful in any railroad machine shop, and will be very extensively used. I can recollect the time when I would have given a good deal if I had known where I could get such tools. Now, I am retired from active service in railroad management, having been 47 years in harness." Among this class of tools is Greenwood's universal planer chuck, shown in figs. 17 and 18.

There are various tools for the same purpose. But these have two serious drawbacks: 1. There is great inconvenience in setting to radii differing considerably, say from 4 ft. to 10 ft., and it is next to impossible to set to a radius of 100 or 1,000 ft. 2. In these the feed must be in a vertical direction, which is very inconvenient for a common planer having the attachment, and the extent of such vertical feed is very small.

But in the new tool the cross-feed of the planer is perfectly applicable; also, any possible radius is at command, and as easily set up as to put a tool into the tool-holder. The tool, it is claimed, is remarkable for possessing these qualities in high degree, and the chuck is simple as it is remarkable. To get a better notion of this tool in a practical sense, imagine a concave surface (cylindric) dressed or planed in a block 1 or 2 ft. wide by 4 ft. long to a radius of 500 ft. Then imagine a convex surface of equal dimensions planed in a second block to an exact fit. The radius might have been 50, 100 or 1,000 ft. just as easily. No pieces are required to be taken out and others substituted to make any of the changes of radius, the chuck being complete in itself, as well as simple.

Though the leading feature of this chuck is its facility and capacity for planing circular curves of large radius, it still possesses other adaptations, including all those of the best planer chucks. For this reason it is styled the universal planer chuck.

The various functions of the chuck will be more clearly understood after describing its parts. The perspective view in fig. 17 gives a good idea of its external appearance, it being shown complete with the guide bar, its bracket and pivot and the arc or quadrant by which the guide bar is set to plane any particular circle. But without these the chuck as shown in fig. 17 will answer all the purposes of the best chucks. It will revolve horizontally to any angle of cut, and can be set by the dial shown, graduated upon the edge of its base. By this movement the chuck and piece can be turned end for end in planing straight work. The vise for holding the work is like a stout trough without ends, in which slides the movable jaw by the screw. This screw has a head at the back side of the chuck, so that in the grip for holding the work, the screw draws instead of pushes. This throws the strain off from the greater part of the bottom of the vise, and springs it much less than otherwise would be unavoidable.

The vise is pivoted to two supports, one on each side, and at the left-hand end in the cuts. These supports project up from the chuck body, within which the vise is placed. Room is allowed at the bottom of the second piece to allow the vise to rise and fall at the right-hand end. It is made to rise and fall in dressing circular surfaces by the crosshead projecting at the back side of the

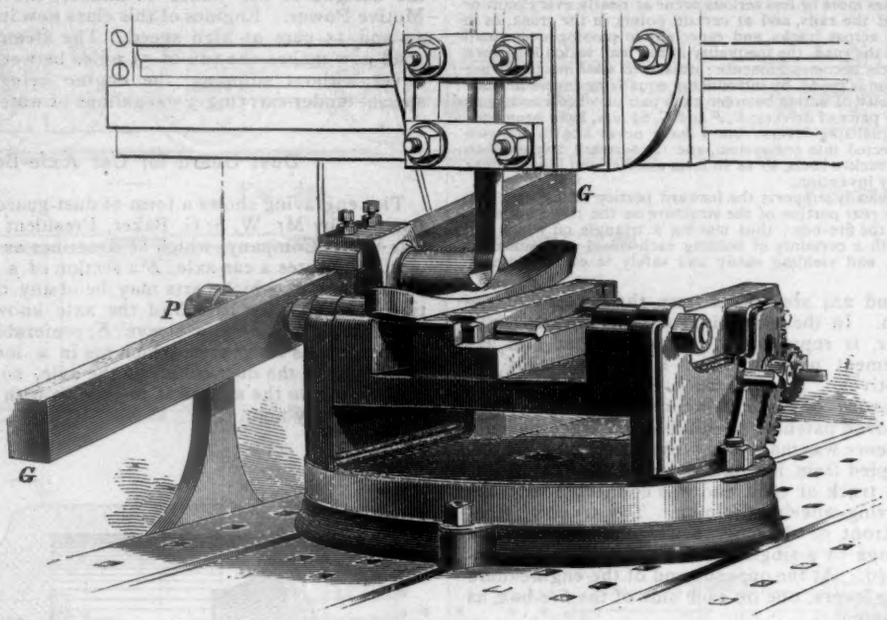


Fig. 17.

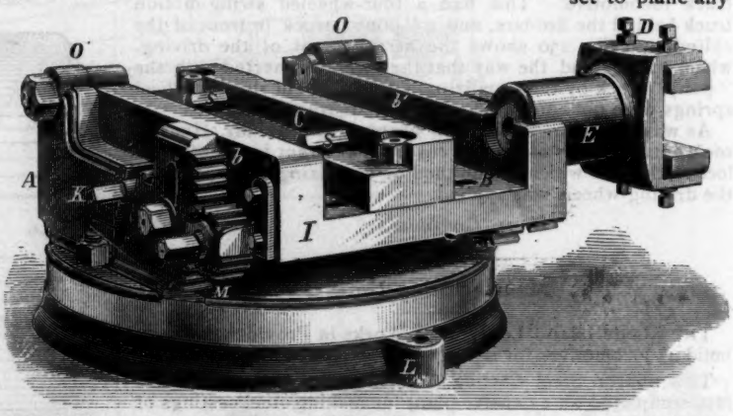


Fig. 18.

GREENWOOD'S UNIVERSAL PLANER CHUCK.

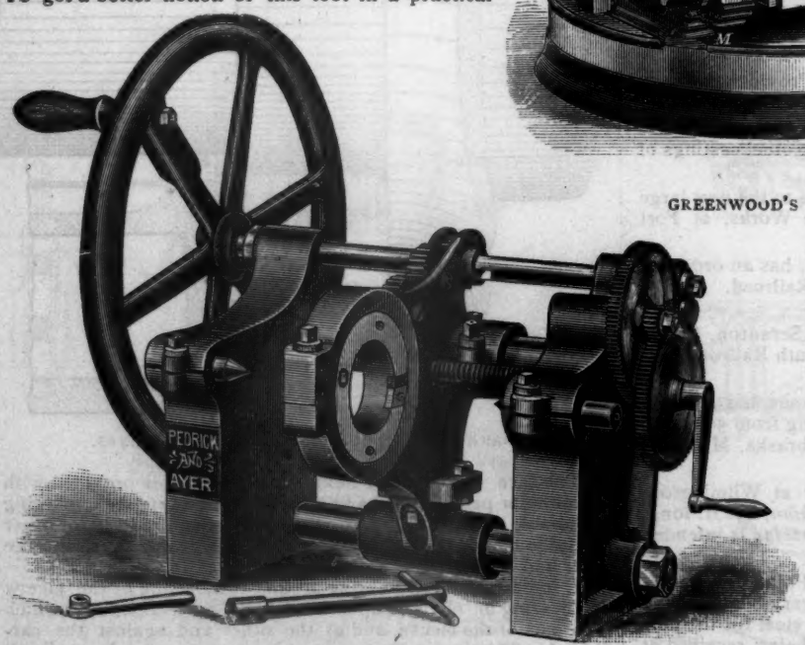


Fig. 19.

PATENT PORTABLE WRIST-PIN MACHINE.

chuck, and sliding upon the guide bar—when the latter is elevated at the end toward the right, a concave surface is planed, and when depressed a convex surface is cut. To change the degree of convexity or concavity the inclination of the guide-bar is to be changed, it being horizontal for planing straight. The guide-bar is fixed at one point by a pivot about which it swings in being raised or lowered at one end. This pivot is supported by a bracket fastened firmly to the frame of the planer below the platen.

The movement by which the circle arc is secured in dressing work is indicated thus: Suppose a piece of work clamped in the vise, and the guide-bar set at an inclination. Then as the platen of the planer is moved forward and back, as in planing, the base of chuck is borne upon it, also the vise and crosshead. But the latter, in sliding upon the stationary inclined guide-bar, must slide on an incline. This makes one end of the vise of chuck rise and fall, the other end being held at a constant height above the platen by the vise pivots. This gives a revolving or swinging motion of vise above a horizontal axis. The cutting tool now being brought to bear upon the piece of work cuts it to the circular arc. The tool can always be so placed as to give a mathematically correct circle.

The vise may be fastened in a horizontal position by a conical pin. The screw in the curved slot in the front side of chuck also aids to clamp the chuck in a horizontal position. This also will clamp the vise at any inclination. When thus clamped at an inclination, a wedge may be planed in the chuck or a key and gib for a connecting rod, etc. When the jaw of the chuck is clamped in any position, as just explained, of course the guide-bar is not required. To use the chuck free from the guide-bar, it may be turned end for end. When the crosshead is freed from the guide-bar by being brought around upon the front side of the chuck the crosshead may be slipped off the end of guide-bar and from the pin on which it works.

In thus turning the chuck around, the trough-shaped piece which carries the vise slides around upon the base piece of the chuck, which latter is bolted fast to the platen of the planer.

The jaw of the chuck has a graduated arc by which the inclination for any wedge or key is easily given. Also the guide-bar has a graduated arc for setting it to any given circle arc. A table is prepared for use in setting the bar at once and correctly. A segmental rack and pinion is applied to the jaw of chuck in such a way that the weight of the jaw is easily lifted by applying a wrench.

Thus we have in this universal planer chuck, the ordinary chuck, a chuck for planing tapers and keys, and the extraordinary novelty of the circle planer for long radii, so that the possession of this chuck enables the workman to do all the various kinds of work described, with the cross-feed of the common planer found in every machine shop, and without other or additional appliances. The chuck is comprised in three principal parts—the bottom plate *L*, by which it is fastened to the planer table, the vise *C*, by which the work is held, and a guide-bar, *G*, held by a bracket on the planer-bed. With these parts it is possible to produce a great range and variety of work.

The truing up of a crosshead pin or wrist-pin by hand, or with bent tools in a lathe is a very expensive job. The work performed by the patent portable wrist-pin machine shown in fig. 19 is very important, reducing the cost of this work very materially. In the planning of this machine, special attention has been directed toward securing facility of operation in the limited space available, and is readily manipulated and handled by the ordinary workman. It consists of two side castings or housings, held together by two parallel rods, ground true. These rods serve as guides, on which the turning device slides. Between the two guide-rods, a screw is placed, as near as possible to the work, and this screw being turned by gearing on the end of the crank-shaft, becomes an automatic feed, which will operate in either direction; or, for convenience in finishing out the fillets at either end of the wrist-pin, this feed can be thrown out, and the device worked by hand.

The sliding arrangement which carries the annular cutter-head or tool-holder is composed of two parts, held firmly together by four steel collar-bolts, the parting line being exactly in line with the guide-rod and feed-screw, and all together are on the center line of the machine.

The cutter-head or tool-holder is of steel, and its division allows it to be adjusted around the wrist-pin to be turned. Gear-teeth, cut out of a portion of its circumference, engage with others, operated by the crank-shaft.

In the housings, centers are placed to hold the crosshead to be operated on. These centers are in line with the main guide-rod, and exactly central to the tool holder.

The tools are inserted in the sides of the tool-holder, and are held in place by screws fitted into holes, countersunk for manipulation by a socket-wrench, and can be readily taken out to grind.

Special care should be taken in laying out the crossheads to be operated on. See that center marks of sufficient depth are made in the end opposite the intended center of the wrist-pin; then place the cutter-head or tool-holder around the wrist-pin, with tools in, set back. Place the crosshead in the machine, on the centers; adjust the sliding frame on the guide-rods, and the work and machine are ready.

These machines are also built for stationary use in shops; and those of the stationary type, being driven by power, are adapted to a great range of work. The machine shown in the accompanying cut is of a size intended for general use in locomotive shops, either on new work, or for truing oval or cut wrist-pins.

Otto's car-box boring attachment, shown in fig. 20, is a simple and cheap method of boring out brasses for car-axle journals. A chuck arranged to be fastened to the table of an ordinary drill press with automatic feed and quick return holds the brasses to be bored, and by simply turning the hand-wheel

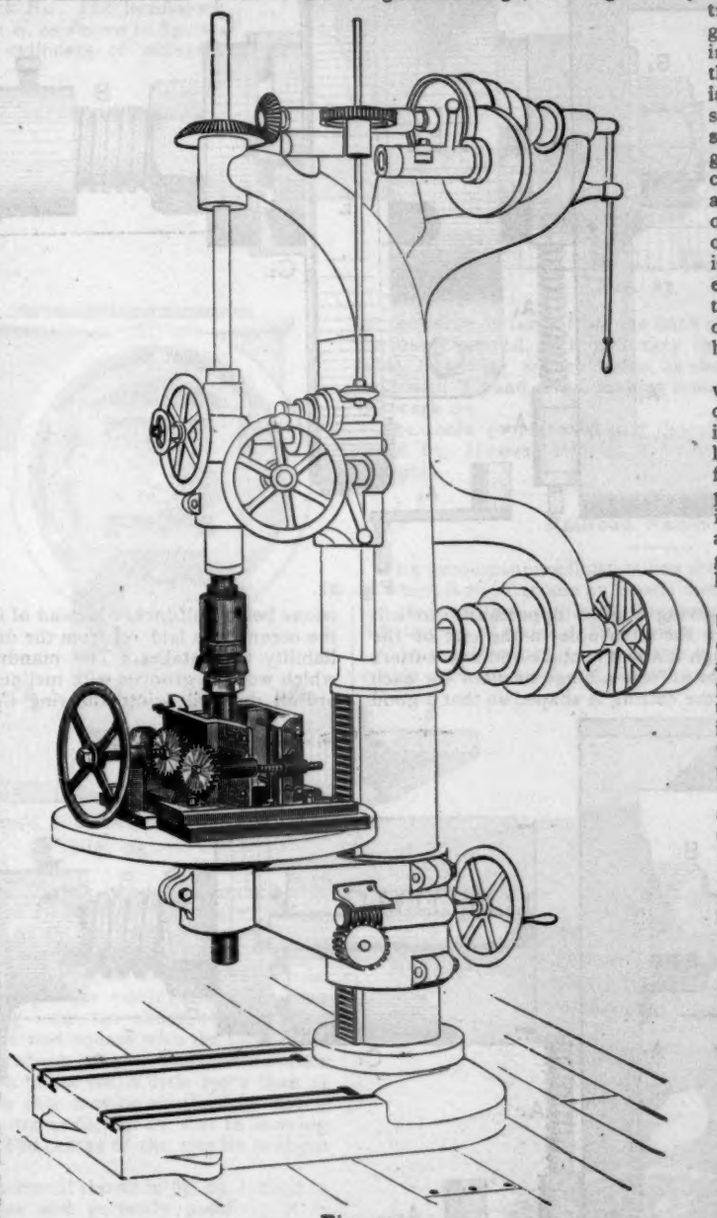


Fig. 20.

OTTO'S CAR-BOX BORING ATTACHMENT.

they are brought together and firmly held in place, a double adjustable cutter boring two brasses at a time. The brasses being less than a half circle, strips are placed between their faces. These strips or parallels are held separately by the set-screws and need not be disturbed when once adjusted for a certain size of box. When different sized boxes are to be bored, then other strips are required. The operation of setting the boxes is as simple as screwing up a vise. The two jaws are adjustable and move toward the center at one time, firmly holding the brasses against the strips. Recesses or sockets are formed in the octagon walls of the chuck, of sufficient width and depth to receive the largest sized brasses. In the rear half of the chuck is a horizontal channel which serves as a passage for chips or borings. Below the chuck is a bearing for the cutter-bar, which is kept free from chips and dirt by a rubber ring, giving a good opportunity to oil. This cutter-bar is fitted into the taper-hole in the end of the drill-press spindle. Through it a slot is made and two cutters with ends rounded are made to form a hinge or pivot for each other. The end that does the cutting is shaped so that a good cutting edge is made when the cutters are set close to the bar for a small hole or extended for a large one. They are designed to bore all sizes of car-axle brasses with one set of cutters. The ends of the cutters are thickened to have a grinding or sharpening surface and are sharpened by grinding on the face of them. They are extended or contracted by a nut, at top and bottom of cutters, which admits of very fine adjustment. This device can be very quickly put in place and at work, and when once adjusted, can be operated by unskilled labor. By having ring-gauges on the bar hung up over the cutters, they can be often tried and the cutters adjusted to bore standard sizes.

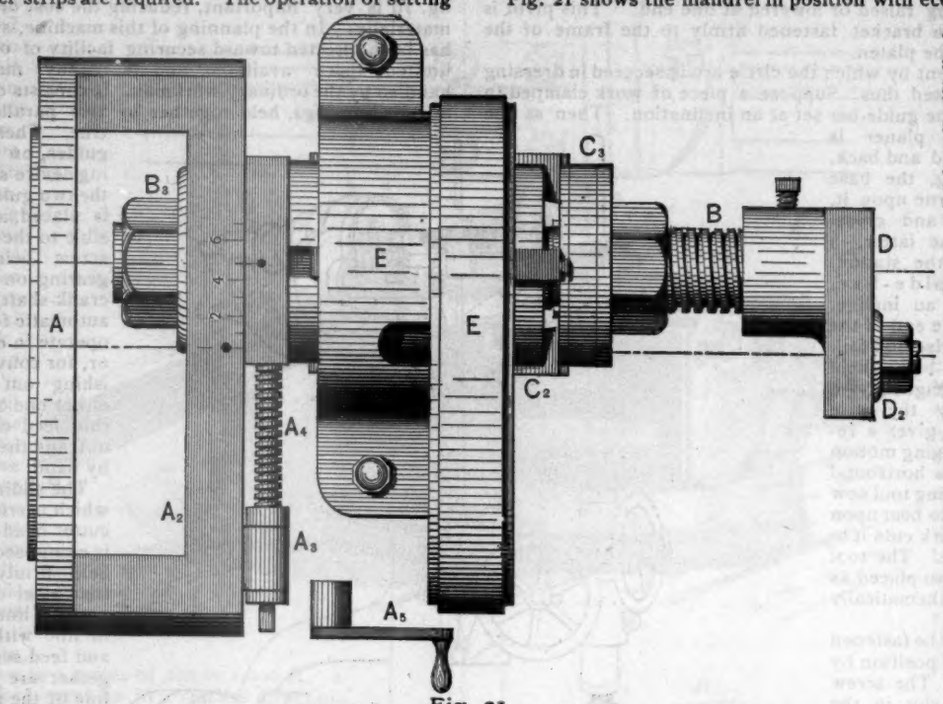


Fig. 21.

Figures 21 and 22 illustrate Hodgson's eccentric mandrel, designed for quickly and cheaply turning up locomotive eccentrics and other eccentric work of a similar kind; it has been used successfully in the shops of the Baltimore & Ohio Railroad.

This machine consists of a face-place, *A*, bolted directly on the face-plate of the lathe, an expanding mandrel, working in a slide, and a center, D_2, sliding in a direction opposite to that in which the mandrel is moved. This center takes a bearing on the dead center of the lathe.

Fig. 21 shows the mandrel in position with eccentric *E* ready for turning. The mandrel is set by the gauge on the bar A_2, and, as shown in cut, is ready to turn an eccentric with a throw of five inches.

Fig. 22 shows the details of the construction. The bar A_2 has a slot in which the block *C* and the mandrel C_3 slide in and out. This block is held in place by the nut B_3. When the nut B_3 on the screw *B* is slacked up, the mandrel C_3 can be moved to and from the center by putting the handle A_5 on the screw A_4. A scale is marked off on A_2, the divisions being half-inches instead of inches, so that the throw of the eccentric is laid off from the drawing directly, without the liability to mistakes. The mandrel carries four wedges, C_3, which work in grooves with inclined bottoms. These wedges are all dovetailed into the ring C_4. As this ring is run in or out, the wedges of course are moved in and out correspondingly. The nut B_3, working on the screw *B*, controls their motion. The block *D* is put on the head of the screw to carry the sliding center D_2, and thus support the mandrel at the outer end. The center is formed on an ordinary T-headed screw with a cup end. This block comes off when a piece of work is to be put in place.

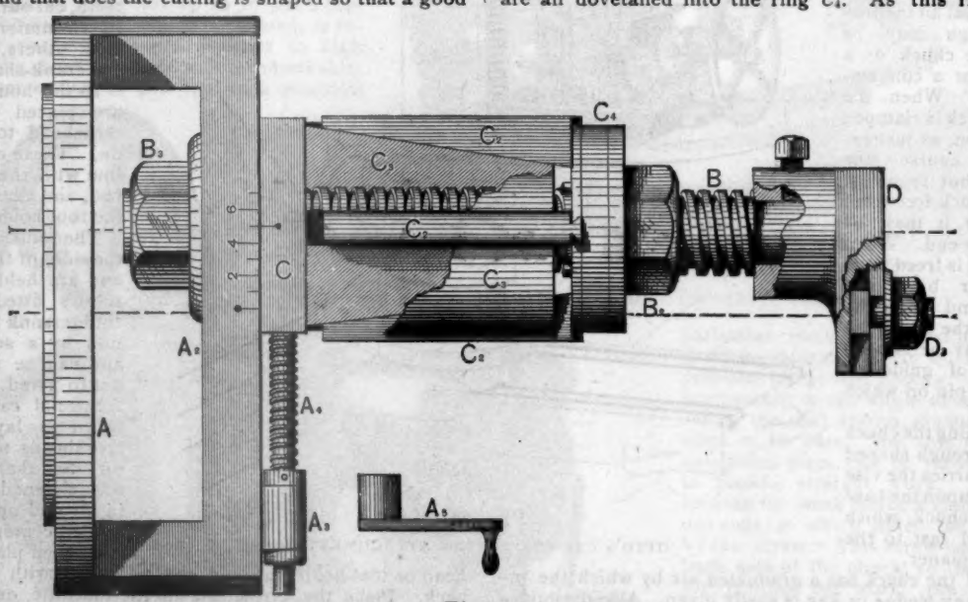


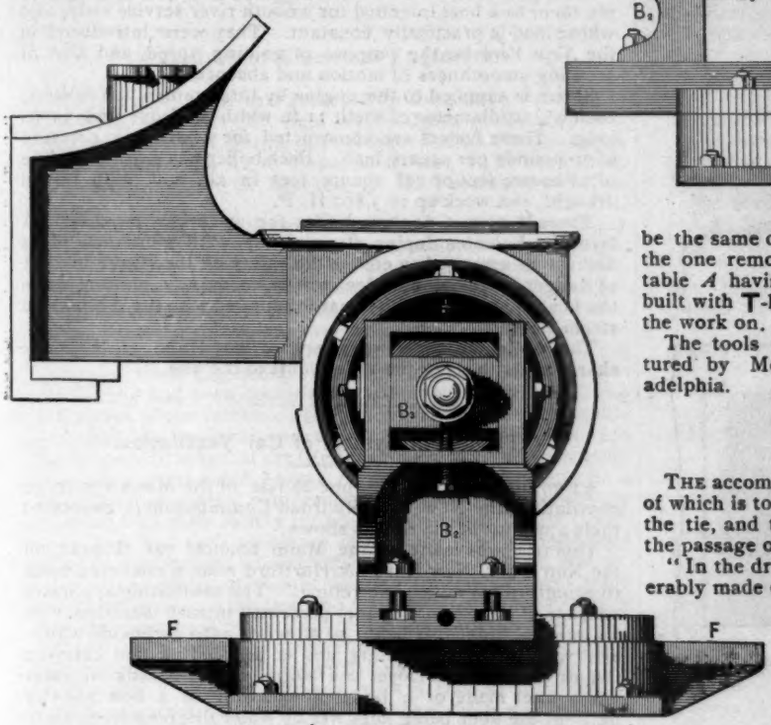
Fig. 22.

HODGSON'S ECCENTRIC MANDREL.

The machine shown in figs. 23 and 24 is Hodgson's cylinder planing chuck, which is used for holding cylinders of all sizes during the operation of planing, and obviates the necessity for setting the cylinder more than once on the planer, the setting being practically automatic.

The chuck consists of a circular base, *A*, which is bolted to the table of the planer, and carries upon its top the revolving top A_2. This revolving top has a bed-plate, *E*, on which there

is one fixed head-stock, D, and a movable one, B_2, between which the cone chucks D D are placed on the spindle C. On these cone chucks the cylinders are held. The upper portion of the table A_2, together with the bed-plate E, revolves on a center fixed in A. The lugs F and C_2 have bolt holes and stops, so as to permit the table to be turned a quarter of a revolution, and accurately squared without trouble in the adjustment. When the cylinder is bored out, no further setting is necessary. The chuck, when put upon a planer, insures the cylinder casting being in line, and enables the cross-planing to be done by merely revolving the base. The spindle C is pivoted at B_1, the opposite end being carried to the block B_3. The head-stock B_2 slides in or out on the base E, as shown in fig. 24, in order to accommodate cylinders of different lengths.



HODGSON'S CYLINDER PLANING CHUCK.

Fig. 24.

The jaws D_2, on the chucks D, slide in and out on the cones to take cylinders of different diameters. They are held by short screws in slotted holes, as will be seen by the section at the right of fig. 23. Fig. 24 shows a cylinder in place, ready for planing the valve seat. By a proper arrangement of the tools, all the planing on the cylinder castings may be done without releasing the casting from the chuck, thus insuring the work being done in line and square with the box. The diameter of the spindles is about 3½ in., and the distance between the cones, as shown in the cut, a little more than 24 in. A greater distance than this may be obtained by taking off some of the washers shown at C_2, fig. 23, and in moving the head-stocks B_2 back. The center of the spindle is about 16 in. from the bed E.

The radius link planer attachment shown in fig. 25, is used in planing curves of any radius and perfectly parallel; it is shown as applied to the ordinary planing machine. In this attachment a pin projecting from a plate bolted to the table of the planer holds an upper table A upon which the work is fastened. Thus the work may be moved forward and backward, and to a greater or less distance from the center-pin, the amount of circular movement determining the radius of the circle to which the work is finished. From the corner of the table A, a wrist projects upwards and takes hold of a slide which is fastened at the required angle to the beam of the planer. When the slide stands parallel to the bed of the planer, the table A will move in a straight line. In proportion to the angle of the slide with the bed of the planer, the table A will be deflected from a straight line into a true curve of greater or less radius.

In setting the link or slide-blocks for planing, the links or blocks require to be moved as well as the radius arm, and it is best to set the ends of work in line with bed at equal distance from center bolt. By shifting the link or block some, it will favor the radius arm and require less angle to do the work. The planing tool, if changed on the same piece of work, must

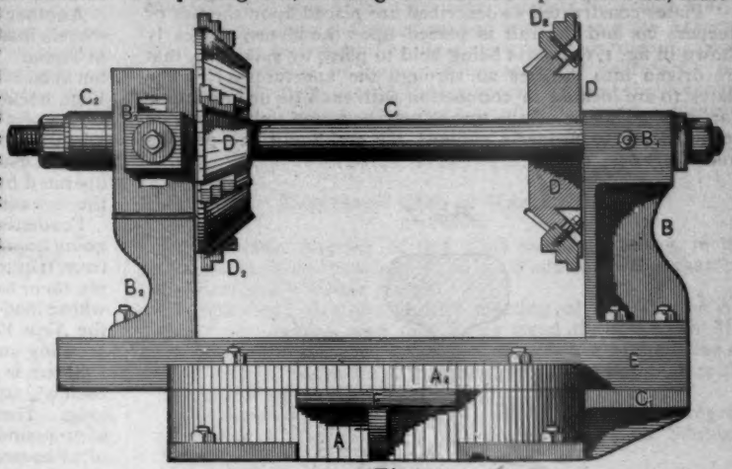


Fig. 23.

be the same distance from the back of the tool to the point as the one removed, or it will vary the radius. Instead of the table A having square holes, as shown in cut, they are now built with T-head slots, making it more convenient for bolting the work on.

The tools represented and described above are manufactured by Messrs. Pedrick & Ayer at their works in Philadelphia.

Railroad Rail-Spring.

THE accompanying illustrations show a rail-spring, the object of which is to interpose an elastic medium between the rail and the tie, and thus diminish the pounding and noise caused by the passage of trains. This device is described as follows:

"In the drawings, 10 represents a metallic plate that is preferably made of steel and shaped to elliptical form, the ends of

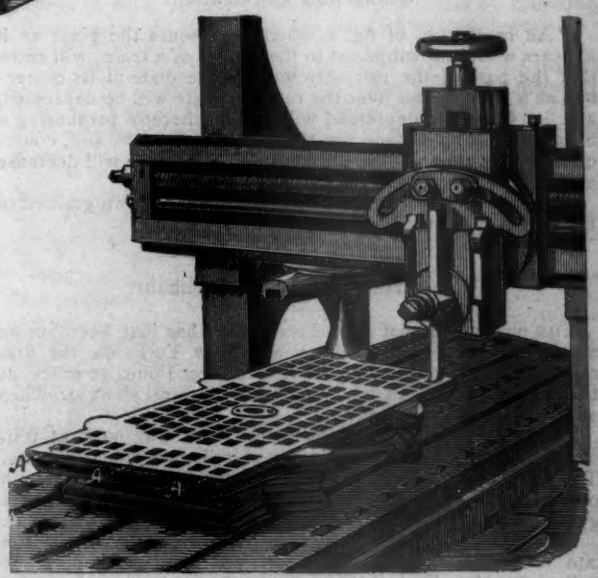


Fig. 25.

RADIUS LINK PLANER ATTACHMENT.

the plate being bent upward, as shown at 2. The upper and lower faces of the plate 10 are non-concentric, thus forming a plate that is thicker in the middle than at the ends.

"In the plate 10 are two slots or apertures, 11. These slots are preferably arranged upon distinct parallel lines and so

located that the distance between their approaching ends will be slightly less than the width of the base of the rail in connection with which the plate is to be employed, thus providing for the flattening of the plates.

"Plates constructed as described are placed upon the ties or sleepers 20, and the rail is placed upon the plates, as clearly shown in fig. 1, the parts being held to place by spikes 15, that are driven into the ties 20 through the apertures 11. The plates 10 are located in connection with each tie or in connection with so many of the ties as may be found to be desirable or necessary to properly support the weight of the passing trains.

Fig. 1.

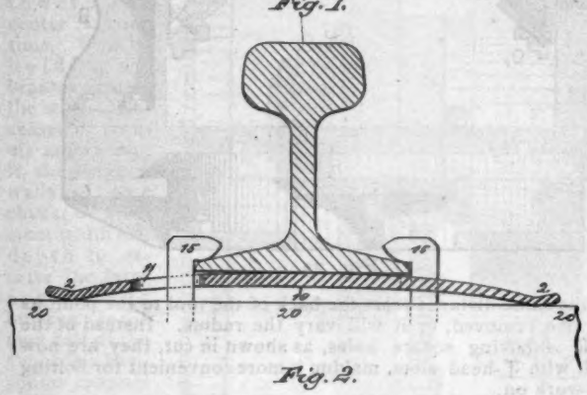
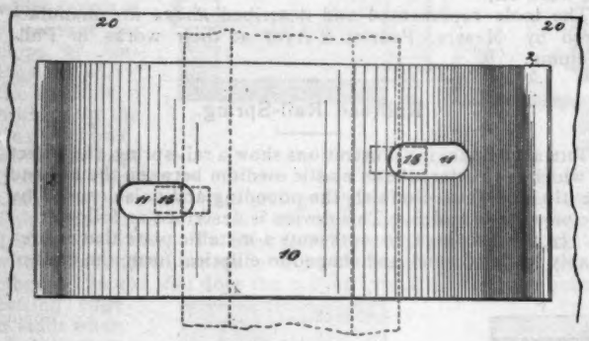


Fig. 2.



OLMSTEAD'S RAIL-SPRING.

"An inspection of fig. 1, which represents the plate as it appears when not subjected to the weight of a train, will show that the base of the rail only touches the plate at its center; but, as a train passes over the rail, the plate will be depressed, and in being so depressed will flatten, thereby presenting a broader bearing-surface for the base of the rail, and, consequently, the effect of the pressure upon the plate will decrease as the plate expands or flattens."

The patent, which is numbered 364,432, has been granted to Edward A. Olmstead, of New York.

New Hudson River Steamboat.

THE new steamboat *New York*, which has just been put on the Day Line between Albany and New York, on the first regular trip (July 18) made the run to West Point, 50 miles, at the rate of 20 miles an hour, and made several short stretches at the rate of 24 miles an hour.

The hull of the *New York* is of iron, and was built at Wilmington, Del., by the Harlan & Hollingsworth Company. The dimensions are: Length on water line, 301 ft.; length over all, 311 ft.; breadth of beam, molded, 40 ft.; breadth over guards, 74 ft.; depth, molded, 11 ft. 3 in.; draft of water, 6 ft.

The model of the sister steamer, *Albany*, designed by the late William Foulks of Greenpoint, was used in shaping the hull of the *New York*, it being changed only to suit the extra 15 ft. in length, 9 in. in depth, and the increased shear fore and aft. A noticeable change is that the wheels are placed aft of the center of length instead of forward, as on the *Albany*.

The engine, which was built by the W. & A. Fletcher Company at the North River Iron Works in New York, is a beam engine of the standard American pattern, with a cylinder 75 in. diameter and 12 ft. stroke, provided with Stevens' cut-off.

The use of a surface condenser, instead of a jet condenser, in this river steamer, is a departure from the usual practice, and this change was made to overcome the evil of using mixed salt and fresh water in the boilers.

Another important departure is the adoption of feathering wheels instead of the usual radial wheels, with fixed buckets or floats. These wheels are 30 ft. 2 in. diameter outside of buckets. There are 12 curved steel buckets to each wheel. Each bucket is 3 ft. 9 in. wide and 12 ft. 6 in. long, with an angle iron 3 × 5 in. on each end. The wheels are overhung or have a bearing outboard on the hull only. The feathering is done in the usual manner by means of driving and radius bars operated by a center placed eccentric to the shaft and held by the A-frame on the guard.

Feathering wheels have been constructed for sound or seagoing boats and for vessels whose load is changed materially from trip to trip; but it is novel, in this country at least, to apply them to a boat intended for smooth river service only, and whose load is practically constant. They were introduced in the *New York* for the purpose of gaining speed, and also of securing smoothness of motion and absence of jar.

Steam is supplied to the engine by three return flue boilers, each 9¼ ft. diameter of shell, 11 ft. width of front and 33 ft. long. These boilers are constructed for a working pressure of 50 pounds per square inch. Each boiler has a grate surface of 76 square feet or 228 square feet in all, and, with forced draught, can work up to 3,850 H. P.

There is also a donkey boiler for use when required. A large De Lamater duplex steam pump, with numerous pipes and valves arranged to ensure the safety of the vessel in case of danger by collision or fire, will be constantly running when the boat is in service. The boat is supplied with the Williamson steam steerer.

The cabin and upper works are of wood and of the same character as those of the other boats of the line.

The Mann System of Car Ventilation.

AT an inspection, made June 22 last, of the Mann system of ventilation, the New York Railroad Commissioners expressed their approval of the results shown.

This trial was made on the Mann boudoir car *Martha*, on the New York, New Haven & Hartford road, a run being made to Stamford (34 miles) and return. The ventilating apparatus consists of an external bonnet presented in each direction, with an internal hinged deflector so attached as to gather air whichever way the car is running, and a descending flue carrying the air down into a closet containing a shallow tank of water and a filter made of a body of excelsior in a box of wire netting, the fiber being kept wet by water dripping from ice in a crate above it. In summer time a large body of ice is also provided in an adjoining apartment of the closet through which the air is carried, after passing through the filter, and from thence it is distributed by a longitudinal flue occupying the inner angle between the wall and floor of the car on one side and extending from end to end. This horizontal flue is provided with outlet openings of small size near the supply end and increasing successively in area to the other end, in order to deliver a substantially uniform current of fresh air from end to end of the car. The horizontal air-flue also contains a system of pipes, which, as we understand, are used in winter time as hot-water pipes, being connected with the stove of the ordinary Baker heater, which is then placed in the air-purifying closet for the purpose of heating the fresh air as it passes through said closet and through the air flue. The air-flue is 14 × 3¼ in., giving, after deducting the space taken up by the heating pipes, a sectional area of 46.42 square inches. The weight of ice carried is about 350 lbs.

Professor W. E. Geyer and Mr. O. Knight, who acted as experts for the Mann Company, found on this trip that at a speed of 25 to 30 miles an hour the air passed through the air-flue at a velocity of 1,796.5 ft. a minute. At this rate 579 cubic feet of air per minute were supplied to the car, or enough to renew all the air in it in 5 minutes. As this car is intended to carry 26 persons, the supply is equal to 22 cubic feet per minute for each person. The experts further say:

"We found by the thermometer that the temperature of the air, where it emerged from the distributing flue into the car, was 62°, while the temperature of the air outside of the car was 82°.

"The vitiated air was constantly discharged from the car by exhaust outlets in the roof. The effect was that, while it was a hot and oppressive day and all the windows and doors of the car were kept shut, the atmosphere was fresh and comfortable during the whole period, and while a majority of the party

were smoking, the tobacco smoke and fumes were constantly carried off so that they were not in any manner oppressive or offensive. * * * *

"In two other coaches attached to the same train having their windows open, and the heat being consequently the same as that of the outside air, there was a sense of oppression which did not exist in the closed boudoir car, presumably due to the fact that the air supplied to this car through the filtering apparatus was cleansed from dust and impurities, and to the further fact that the air within was less humid by 2° than the outer air, as shown by the indications of a standard hygrometer."

Proceedings of Societies.

Institute of Electrical Engineers.

The last meeting of this Institute for the season was held in New York, June 28. Mr. Geo. W. Blodgett, of Boston, read a paper on Electric Lighting of Passenger Trains. A discussion followed by Messrs. R. W. Pope, Elias Ries, T. D. Lockwood, C. O. Mailloux, W. C. Bracken, J. M. Pendleton and Jos. Wetzler.

Before the paper of the evening was read, the House Fund Committee, through its Chairman, made a report of its progress. The subscription had increased to $4,500, almost entirely within the membership, with $1,000 additional virtually pledged by a gentleman greatly interested in the work of the Institute. A feature of the report was the committee's statement of the support and co-operation extended to the Institute by the Society of Civil Engineers. The President and Secretary of that Society had been appointed to confer with the House Fund Committee of the Institute upon plans for joint use of suitable premises. In the conference that was held Mr. Worthen and Mr. Bogart, in behalf of the Civil Engineers, expressed heartily their sense of the rapid growth of electrical engineering as a department of general engineering, and their desire to ally the Institute with their society for mutual advantage. Civil engineers were finding it necessary to increase their acquaintance with the applications of electricity, in order to meet the demands upon them of clients desiring to consult them upon questions of electric traction and transmission of power, while the constantly broadening field of the application of electricity calls for much general engineering knowledge on the part of electrical engineers. A location in common, an assembly room in common, a union of libraries, with a suitable provision of separate apartments for the use of each society would, it was thought, be of much mutual benefit. It was thought likely that the Society of Mechanical Engineers would come into such a scheme, and that ultimately all branches of engineering would have a common headquarters in New York. The plan first suggested at the conference of committees, viz., the purchase of a house adjoining the present building of the Civil Engineers, had fallen through, the owner being unwilling to sell. The Institute committee would have a further conference with the Civil Engineers' committee in respect to further plans —among them that of the erection of a suitable house large enough to accommodate both societies.

Roadmasters' Association of America.

THE fifth annual meeting of this Association will be held at the Kennard House, in Cleveland, Ohio, beginning at 10 A. M. on Tuesday, October 11, next. The meeting is expected to continue for three days.

The Committee appointed to prepare a programme of questions for discussion at this meeting have submitted the following: 1st. Unfinished business. 2d. Standard Guard Rails for Frogs. 3d. Standard Frogs. 4th. Standard Guard Rails for Bridges and Re-railing Safety Frogs at Bridges. 5th. Standard Track Joints. 6th. Standard Rail. 7th. Standard Hand-Cars.

All roadmasters and track supervisors are respectfully invited to be present at this, the fifth annual meeting of the Association. Arrangements are now under progress whereby it is hoped to arrange with railroad managements to pass all delegates (and their wives) who hold a certificate, issued by the Association, showing him to be a delegate to this convention.

All who can meet with the Association will please notify the Secretary, H. W. Reed, Way Cross, Georgia, of their intention to do so, and he will furnish delegates with certificates, should the several railroad managements consent to honor them in lieu of a pass. Should the Association be denied this mode of transportation, delegates will be promptly notified, in order that each one may make other arrangements for passes.

Those who are not members and wish to join the Association, and cannot spare the time to attend this meeting, may become members by corresponding with the Secretary. Arrangements have been made for special rates at the Kennard House, in Cleveland, thus insuring all who attend a pleasant stay in the city.

Engineers' Club of Kansas City.

A REGULAR meeting of this Club was held July 5, in the Club-room, Vice-President J. A. L. Waddell in the chair; 9 members and 1 visitor present.

It was voted that the regular meeting of the Club on August 1 be omitted, and that in its stead the Club, on Mr. Chanute's invitation, visit the work in progress at that time on the Chicago, Santa Fé & California Railroad bridge over the Missouri River at Sibley.

The Secretary presented for Mr. H. C. Pearsons his regrets at finding it impossible to prepare the paper on Standard Time, which he had promised.

Mr. Waddell mentioned some experiments on the Strength of Cast-Iron Cable Yokes, made in St. Louis recently by Prof. J. B. Johnson and himself.

At the request of Mr. Mason the Secretary read abstracts from the annual address of the retiring President of the Engineers' Club of Philadelphia.

The Secretary presented for Mr. G. W. Pearsons a set of excellent photographs showing the progress of construction on the new Kansas City Water Works at Quindaro and Kaw Point; also from the American Society of Civil Engineers reports of the various committees on Standard Time, with other papers referring to the subject.

American Society of Civil Engineers.

THE annual convention of the Society practically began on Friday morning, July 1, when a large number of members left New York on the Albany Day Line steamboat. At Rhinebeck they landed and were transferred by ferry to Rondout, whence special trains carried them over the Ulster & Delaware, the Stony Clove & Catskill Mountain and the Kaaterskill roads to the Hotel Kaaterskill.

Arrived there, the members were gathered on the grand plateau in front of the hotel, and Mr. William G. Hamilton, Chairman of the Committee on the Convention, presented a very witty address of welcome.

The emblem of the Society—a white flag with the coat-of-arms in the center—was unfurled, after which the members sang an original composition, entitled "Salute to the Flag." All hands then formed a circle, and the wassail cup was passed around.

After singing and the wassail bowl, supper followed, at which each lady was presented with a bouquet of flowers and the compliments of the Society.

On Saturday, July 2, the convention was called to order and Mr. T. C. Clarke was chosen Chairman.

The first business was discussion on the Inspection and Maintenance of Railway Structures. Written discussions were presented by Messrs. John A. Wilson, of Philadelphia; Willard S. Pope, Detroit; Charles A. Marshall, Johnstown, Pa.; Albert Lucius, New York; Andrew Bryson, New York; E. P. Dawley, New York, Providence & Boston Railroad; Samuel T. Wagner; E. S. Philbrick, Boston; J. M. Goodwin, Sharpsville, Pa., and J. M. Wilson. The subject was discussed verbally by Messrs. Theodore Cooper, D. J. Whittemore, Stanley H. Goodwin, A. M. Wellington, P. Roberts, C. C. Schneider, Frederick Graff, Wm. Kent and others.

At the evening session President Worthen read his annual address, which was a summary of engineering progress during the year, and was full also of interesting reminiscences of the past.

Sunday, July 3, there were religious services at the hotel, and a very appropriate sermon was preached by Rev. Mr. Miller, of Philadelphia.

On Monday, July 4, a short session was held, at which Mr. G. H. Thompson read a paper on the old locomotive *De Witt Clinton*. Mr. J. F. O'Rourke read a detailed description of the Poughkeepsie Bridge.

Mr. Collingwood, as Chairman of the Committee on Cement Tests, made a report, which was discussed by Messrs. D. J.

Whittemore, J. M. Worthen, D. F. Noyes, William J. McAlpine, F. C. Prindle, J. F. Flagg, J. Bogart, C. Tompkins, E. P. North, E. Kuichling, E. P. Clarke, P. P. Dickinson and B. F. Church.

In the afternoon a special business meeting was held for the purpose of raising a building improvement fund to be devoted to the improvement of the Society House in New York City, or to erect a building better adapted to the requirements of the Society on some other site. A subscription was started and in less than an hour $5,025 was raised.

In the evening the members attended a ball in the parlors of the hotel.

On Tuesday, July 5, a large number of the members left the Hotel Kaaterskill in the morning to visit the Poughkeepsie Bridge. They were taken from Rondout, on boats provided by the Union Bridge Company, to the bridge. Every portion of the bridge accessible was examined by them, and all were bountifully supplied with refreshments before returning, which was late in the evening. The members who remained at the hotel witnessed a severe mountain storm. The forenoon was misty, followed in the afternoon by a severe storm of both rain and wind. Only a little rain was seen by the members visiting the bridge.

On Wednesday, July 6, Mr. R. E. McMath was called to the chair, Mr. Clarke being absent. Mr. Frederick P. Stearns read a paper on Disposal of Sewage in Massachusetts. A written discussion on this paper, by Charles Allen, was read, and the two papers were verbally discussed by Messrs. E. C. Clarke, Emil Kuichling, R. E. McMath, B. S. Church and W. H. Wiley.

Professor Thurston called attention to the question whether the "Land-grant Colleges" were fulfilling the purposes for which they received donations of public lands.

In the afternoon Mr. G. Leverich read a paper on Cable Railroad Propulsion.

Professor R. H. Thurston presented a blue print taken by a new process. Detailed plans were exhibited showing the method of disposing of sewage in Newark, N. J.

In the evening a business meeting was held, at which Messrs. Wm. H. Paine, Clemens Herschell, Frederick Graff, R. E. McMath and C. H. Latrobe were appointed a committee to nominate officers to be voted for at the annual meeting.

A resolution was then presented by R. E. McMath for the purpose of taking the sense of the meeting:

"*Resolved*, That it is the sense of this meeting that it is expedient to create a grade of *students of the Society*, said grade to consist of young men over 18 and under 25 years of age, who are engaged in the study or practice of engineering. Connection with the Society to cease as each individual student reaches the age of 25, unless he shall be previously elected to a higher grade."

The privileges proposed to be granted by this grade are, attendance at meetings, and to receive the transactions of the Society by the payment of a small fee.

After a long discussion the resolution was referred to a special committee, to be appointed by the President, which is all that could be done by this convention. To make any change in the constitution it will be necessary to submit a resolution at the annual meeting in January, and then, if passed, this resolution will be sent out for ballot to all the members of the Society.

The President appointed on the special committee Robert E. McMath, W. H. Paine, R. H. Thurston, Robert Moore, Frederick Brooks.

Mr. E. P. North introduced the following resolution for the purpose of bringing the subject before the Society, which was introduced by Professor Thurston at a previous meeting:

"*Resolved*, That the Board of Direction of the Society be requested to consider the advisability of appointing a Committee on Technical Education and Professional Training, which shall annually report to the Society the state and progress of such instruction in the United States and Europe as well, together with such data, statistics and suggestions relative to the subject as may seem to them proper. Said committee to co-operate with similar committees of other engineering societies, should such be advisable.

"*Resolved*, That such committees give especial attention to the matter of the formation and administration of those institutions known as the 'Land-grant Colleges,' established by the several States under the Morrill bill of 1862, and report to what extent said colleges are carrying out the original leading objects prescribed by the funds donated under that law have been applied to such leading objects, and to what extent, if at all, diverted from their original purpose; and, further, to report what manner said funds may be in the future, in the opinion of the committee, rendered most useful in the promotion of the industrial arts and the education of the industrial classes."

This was referred to the Board of Direction.

On Thursday, July 7, the Secretary read a letter from an officer of the Panama Canal Company (M. Colné) taking exception to statements made by M. Boulangé at a recent meeting of the Society. The subject was discussed by several members.

A discussion of Professor Robinson's paper on Vibration of Bridges, was read by T. H. Johnson. This was followed by papers by W. H. Booth on Stresses of Bridges; C. A. Marshall on Compressive Strength of Iron and Steel; M. Moulton on the Kentucky & Indiana Bridge over the Ohio at Louisville.

A discussion on A. M. Wellington's paper on the American Line from Vera Cruz to the City of Mexico was read by Mr. O. L. Nichols, and replied to by Mr. Wellington.

In the evening the closing session was held, when the subject of the Maintenance and Inspection of Bridges was taken up again and discussed by Messrs. J. M. Wilson, G. H. Pegram, J. A. L. Waddell, J. Bouscaren, G. Lindenthal and J. S. Dagron.

The convention then adjourned.

On Thursday evening the annual banquet was held at the Hotel Kaaterskill. Mr. W. G. Hamilton presided and 130 members and guests were at the table.

On Friday, July 8, the members left the hotel and went by rail to Kingston. Here some of them continued on their way home, while others left the train for Binne Water to examine the cement works, by invitation of F. O. Norton.

After the inspection of the cement works and lunch the party returned to Kingston and left by West Shore train for New York, where they arrived early in the evening.

An adjourned business meeting was held in New York, July 13. The following were declared elected members: John Ferris Alden, Rochester, N. Y.; Frank M. Ashmead, Hulton, Pa.; Wm. H. Breithaupt (promoted from Junior), Kansas City, Mo.; Ulysses Stanislaus Lutz, Bloomsburg, Pa.; James M. Shanly, Montreal, Canada.

The following circular has been issued:

"At an informal meeting held at the Hotel Kaaterskill on July 4, 1887, at which a number of the members of the Society were present, the President, Mr. William E. Worthen, stated that the Society has grown to such extent that the present house had become inadequate, particularly for the meetings and for the convenient use of the library, and that it seemed of great importance to the welfare of the Society that something should be done either towards building an addition to the present house, or, if it were practicable, the purchase of larger and more commodious quarters.

"The following resolutions were adopted:

"'*Whereas*, the accommodation of the present Society building is entirely inadequate for the purposes of the Society, and it is deemed advisable without delay either to provide new quarters or an enlargement of the present building.

"'*Resolved*, That the members and friends of the Society are urged to contribute to the Building Fund as they may be able, in order that immediate measures may be taken by the Board to accomplish this object.

"'*Resolved*, That the Board in its discretion may expend a reasonable sum in an addition to the present building.'

"The sum of $5,225 was directly subscribed by gentlemen present.

"The Board of Direction desires to take measures either towards the enlargement of the present house or towards the purchase of other property. The determination as to which of these courses shall be taken must depend largely upon the amount of subscriptions to the Building Fund which shall be received within a short time. The subject therefore is presented to the members and friends of the Society. The Board of Direction feels that something must be done, and asks such response as may aid it in determining what is for the best interests of the Society."

Master Mechanics' Association.

Mr. ANGUS SINCLAIR, Secretary, issues a circular giving the following list of subjects for the next convention, with the committees appointed by President Setchel to report on each subject:

1. Relative Proportions of Cylinders and Driving Wheels to Boilers: Charles Blackwell, Clem Hackney, J. J. McGrayel.

2. Guides: James N. Lauder, W. J. Robinson, H. S. Kolseth.

3. Extension Smoke-boxes, and Brick and other Fire-box Arches: John Hickey, W. L. Foster, E. L. Weisgerber.

4. Springs and Equalizers: John Mackenzie, J. S. Porter, Wm. Swanston.

5. Tires; Advantage, or Otherwise, of Using Thick Tires: J. W. Stokes, C. E. Smart, Henry Schlacks.

6. Purification or Softening of Feed-Water: Herbert Hackney, John Player, W. T. Small.

7. Prevention of Dangerous Escape of Live Coal and Sparks from Ashpans: G. W. Ettenger, E. D. Anderson, W. H. Thomas.

8. Tender Trucks: E. M. Roberts, H. D. Gordon, H. D. Garrett.

9. Traction Increasers in Connection with Over-Cylindered Engines: J. Davis Barnett, F. L. Wanklyn, T. J. Hatswell.

10. The Magnetic Influence of Iron and Steel in Locomotives on the Watches of Engine-Runners: James Meehan, Harvey Middleton, T. W. Gentry.

11. Amendment of the Constitution: J. Davis Barnett, M. N. Forney, A. Pillsbury, J. N. Lauder, Angus Sinclair.

Committees to prepare Obituaries or Memorials of Deceased Members: On WILLIAM WOODCOCK: Thomas Millen, C. G. Williams, L. M. Ames. On H. G. BROOKS: M. L. Hinman, George W. Stevens, W. F. Turreff. On GEORGE COLBY: A. B. Underhill, O. Stewart, John Thompson. On W. W. EVANS: M. N. Forney, Reuben Wells, E. H. Williams. On GEORGE E. HOWE: J. M. Foss, J. T. Gordon, A. Pillsbury.

The address of the Secretary is now No. 175 Dearborn Street, Chicago.

Engineers' Club of Minneapolis.

AT a regular meeting held in Minneapolis, Minn., June 24, President G. W. Sublette was appointed a delegate to the convention of the American Society of Civil Engineers. A joint committee was appointed to arrange with the St. Paul Club for an excursion.

On motion the President appointed Messrs. Cappeler, Pike, Houston, Redfield and Pardee a Standing Committee on Tests of Materials, to confer with the State University authorities with reference to a series of tests of local materials to be conducted with a view of correcting the tables on strength of materials.

Car-Wheel Manufacturers' Association.

AT a meeting recently held, a number of the manufacturers of car-wheels agreed to form an association for the purpose of discussing questions in connection with the manufacture of car-wheels, the best methods of making and testing wheels and similar matters. Another object of the Association is to endeavor to secure uniform sizes of wheels and uniform methods of testing. With a view to secure the concurrence of railroad officers in some of these points, especially as to a uniform system of testing, the Association appointed a committee to confer with the Master Mechanics and the Master Car-Builders. Both of those associations have appointed committees to confer with the car-wheel manufacturers, thus forming a joint committee which will probably hold several meetings during the year.

The Association does not intend in any way to arrange or influence the prices of wheels, its object being merely to discuss questions connected with their manufacture. Any car-wheel maker can join it, if he desires.

The officers of the Association are: President, W. H. Barnum; Vice-President, J. H. Bass; Secretary, W. W. Lobdell; Treasurer, N. P. Bowler; Executive Committee, J. R. Whitney, W. W. Snow, N. S. Boughton and E. B. Tippetts.

The following is the Constitution adopted by this new Association:

ARTICLE 1. *Preamble.*—The object of this Association is for the purpose of securing stated meetings, to interchange views, and consider various subjects as may be thought best for their mutual advantage.

ARTICLE 2. *Name.*—The organization shall be known as the Chilled Car-Wheel Manufacturers' Association.

ARTICLE 3. *Management.*—The affairs of the Association shall be conducted by a President, Vice-President, Secretary and Treasurer, who, with a board of managers, consisting of five members, shall form an Executive Committee, such officers to be elected at their annual meeting.

ARTICLE 4. *Finances.*—The funds of the Association shall be under the control of the Executive Committee, who shall make assessments at such times as may be necessary to meet the actual expenses of the Association.

ARTICLE 5. *Membership.*—Anyone engaged in the manufacture of chilled cast-iron car wheels is entitled to membership in the Association by signing its Constitution.

ARTICLE 6. *Meetings.*—The Executive Committee shall provide for annual meetings, and for such special meetings as it may deem fit for the interest of the Association, and it shall, at the written request of one-third of the membership of the Board of Managers, call special meetings.

ARTICLE 7. *Amendments.*—This Constitution may be altered or amended by a two thirds vote of the members of the Association present, either in person or by proxy, at any of the meetings called for that purpose, with notification of such proposed change, which shall be given 20 days previous to the meeting.

Association of Railroad Telegraph Superintendents.

THE sixth annual meeting began at the Tremont House, Boston, July 13, President A. R. Swift in the chair. A number of new members were admitted.

The chief discussion of the first day's session was upon the subject of superfluous and improper messages sent over the railway telegraph wires and the best method for detecting them and enabling the superintendents to obtain tolls on same. It was suggested that a committee be appointed to ascertain if an instrument could be devised and manufactured for the purpose of detecting and recording all messages passing over the wires and to be termed an automatic recording register. After the unanimous vote of those present in favor of this suggestion, it was decided upon that the committee referred to should visit the great commercial telegraph offices in New York, and there inspect the various kinds of apparatus in use. President Swift appointed the following committee for the purpose named: Messrs. S. S. Bogart, W. J. Holmes, C. E. Topping, C. Selden and M. Magiff. It was then agreed upon that this committee be authorized to extend an invitation to manufacturers of recording instruments to submit plans for a recording register which would meet the requirements of the members of the Association.

After inspecting a number of exhibits of electrical apparatus, the members went on a steamboat excursion to Nantasket Beach.

On the second day Mr. G. L. Lang, Chairman of the Committee on the Alphabet, reported on the advisability of substituting something in place of the long dash to represent the cipher. While the desirability of some substitute was acknowledged, no agreement could be reached as to what to substitute, and the Committee, therefore, made no recommendation. There was an interesting discussion on the report, and, while all of the speakers acknowledged that some change ought to be made, inasmuch as the same symbol is used to represent the letter L and the cipher, no one suggested any substitute It was finally voted to instruct the Committee to decide for the association upon some symbol. Mr. Lang declined to serve longer, and the committee was constituted as follows: Messrs. Selden, Holmes and Topping.

It was voted to hold the next meeting in New York on the second Wednesday in July, 1888. The Association proceeded to the election of officers, which resulted as follows: President, George L. Lang, New York & New England; Vice-President, G. C. Kinsman, Wabash; Secretary and Treasurer, P. W. Drew, Chicago & Eastern Illinois.

A general discussion took place upon the use of electricity in connection with track signals, lighting of cars, etc., and various gentlemen told about their acquaintance with the subject on their own lines of railroad.

After a short discussion on the Telegraphers' Union and some routine business, the convention adjourned.

Fast Steamers.—The fast time made by the steam yacht *Stiletto*, built by the Herreshoffs at Bristol, R. I., attracted much attention last year. As has been already noted, the *Stiletto* has been sold to the Navy Department. The Herreshoffs have just completed a yacht for Mr. N. L. Munro, of New York, which made on its trial trip from Newport to New York an average speed of 24 miles an hour. This yacht, which is named *Now Then*, has the following measurements: Length over all, 85 ft.; water line, 81 ft.; beam, 10 ft.; draft of water, 3 ft. 3 in. Her speed, however, does not quite equal that attained by some English torpedo-boats.

PERSONALS.

Mr. F. T. Perris is Chief Engineer of the new California Central Railroad.

Mr. Charles M. Babbitt is Chief Engineer in charge of the location of the new Arkansas & Louisiana Railroad.

Mr. C. H. Prescott has resigned his position as Manager of the Oregon Railway & Navigation Company's lines.

Major James F. Gregory, U. S. Engineers, is assigned to duty as Engineer Secretary of the Lighthouse Board.

Lieutenant-Commander John K. Winn has been ordered to duty as Inspector of the Seventh Lighthouse District.

Mr. J. A. Cooper has resigned his position as Master Mechanic of the New York, Pennsylvania & Ohio Railroad.

Mr. John Adair has been appointed Master Mechanic in charge of the Baltimore & Ohio shops at Grafton, W. Va.

Mr. T. P. Jacob has resigned his position as Master Mechanic of the Third Division of the Mexican Central Railway.

Captain John C. Mallery, U. S. Engineers, is assigned to duty as Engineer of the Fifth and Sixth Lighthouse Districts.

Major David P. Heap, U. S. Engineers, is assigned to duty as Engineer of the Third and Fourth Lighthouse Districts.

Mr. Frederick Mertzheimer has been appointed Master Mechanic of the Kansas Division of the Union Pacific Railway.

Lieutenant-Commander Joseph F. Noel, United States Navy, has resigned his commission, to take effect immediately.

Mr. George Leighton is Chief Engineer of the Mobile & Dauphin Island Railroad, and has his office in Mobile, Alabama.

Mr. W. Bradburn has been appointed Resident Engineer of the Texas & Pacific Railway, with headquarters at Marshall, Texas.

Mr. G. C. Dunham is appointed Engineer of the Lake Shore & Michigan road, in place of O. D. Richards, transferred.

Mr. Jonathan Barrett is Chief Engineer of the new West Virginia Railroad, and has his headquarters at Morgantown, W. Va.

Mr. Samuel W. Armistead has been appointed Assistant Naval Constructor in the United States Navy, to date from June 30.

Mr. O. H. Tripp, of Rockland, Me., is Chief Engineer of the Camden, Rockport & Rockland Railroad, now under construction.

Mr. Charles M. Hays is appointed General Manager of the Wabash Western Railroad, to succeed A. A. Talmage, deceased.

Lieutenant J. V. B. Bleecker, U. S. N., has been ordered to duty as inspector of steel for the new cruisers now under construction.

Mr. W. A. Pratt has been appointed Engineer of Maintenance of Way of the Philadelphia Division of the Baltimore & Ohio Railroad.

Mr. Samuel Eagan has been appointed Master Mechanic of the Colorado Division of the Union Pacific Railway, with office in Denver.

P. E. Le Fevre, U. S. N., has been appointed Superintending Engineer of the Ocean Steamship Company, with office in New York.

Mr. H. B. Hodges, Chemist of the Union Pacific Railway, has been made Acting Engineer of Tests in place of C. H. McKibbin, transferred.

Mr. Elliott Holbrook, late Chief Engineer of the Pittsburgh & Lake Erie Railroad, has been appointed General Superintendent of that road.

Lieutenant J. M. Robinson, U. S. N., has been detached from the *Minnesota* and ordered to duty as Inspector of steel for the new cruisers.

Mr. C. H. McKibbin, late Engineer of Tests of the Union Pacific Railway, has been appointed Storekeeper of the road, with office in Omaha.

Captain Richard W. Meade, U. S. N., will take command of the Washington Navy Yard in September, relieving Captain Rush A. Wallace.

Major Joseph P. Farley, U. S. Ordnance Corps, is assigned to duty as a member of the board for testing rifled cannon, with station at New York.

Colonel William Kerrigan has resigned his position as General Superintendent of the Missouri Pacific Railway, and will engage in other business.

Captain Otto E. Michaelis, U. S. Ordnance Corps, is assigned to the command of the Kennebec Arsenal, Maine, relieving Major Frank H. Phipps.

Mr. A. M. Miller is appointed Master Mechanic of the Cascade Division of the Northern Pacific Railroad, with office at Ellensburg, Washington Territory.

Major Frank H. Phipps, U. S. Ordnance Corps, is assigned to the command of the United States Powder Depot, Dover, N. J., relieving Major Joseph P. Farley.

Mr. S. B. Crawford has been appointed Master Mechanic of the Baltimore & Ohio Railroad shops at Mt. Clare, Baltimore, in place of Adam Beckert, resigned.

Commodore James A. Green, U. S. N., has been detached from duty as President of the Naval Examining Board, and ordered to command the European station.

Mr. O. D. Richards is appointed Engineer of the Michigan Southern Division of the Lake Shore & Michigan Southern Railroad, in place of Benjamin Reece, resigned.

Mr. George W. West has been appointed Master Mechanic of the Eastern Division of the New York, Pennsylvania & Ohio Railroad, succeeding J. A. Cooper, resigned.

Dr. Thomas B. Comstock, Professor of Mining Engineering in the University of Illinois, at Champaign, has been appointed Assistant Geologist for the State of Arkansas.

Mr. T. Tresize has been appointed Master Mechanic of the Philadelphia Division of the Baltimore & Ohio Railroad. He was recently General Foreman of the shops at Sandy Hook.

Mr. H. S. Rowe, Superintendent of the Oregon Railway & Navigation Company's lines, will hereafter perform the duties of Manager, in place of Mr. C. H. Prescott, who has resigned.

Mr. Washington Lavery has been appointed Master Mechanic of the Mahoning Division of the New York, Pennsylvania & Ohio Railroad, succeeding George W. West, transferred.

Mr. Charles Macdonald, of the Union Bridge Company, has started for Australia, on business connected with the Hawkesbury Bridge. He expects to be gone three or four months.

Mr. William F. Durfee, a well-known metallurgist and engineer, has been appointed General Manager of the Pennsylvania Diamond Drill Company, whose works are at Birdsboro, Pa.

Mr. George Gibbs has been appointed Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway, and will have his headquarters in Milwaukee. He has been Engineer of Tests for some time.

Mr. James Carton has been appointed Roadmaster of the Gulf, Colorado & Santa Fé Railroad, with headquarters at Fort Worth, Tex. He was recently on the Jeffersonville, Madison & Indianapolis road.

Mr. E. L. Corthell, who, for three years has held the position of Chief Engineer of the Tehuantepec Ship Railway is to retain that position. The report that Colonel Andrews, of Allegheny, Pa., is to take this position is without foundation.

Mr. W. P. Freret, has been appointed Supervising Architect of the Treasury Department in place of M. E. Bell, resigned. Mr. Freret is a well-known architect of New Orleans, and has had charge of some important works in that city.

Mr. Robert B. Lyle, for some time past connected with the Missouri Car & Foundry Company, and formerly Purchasing Agent of the Missouri Pacific Railroad, has been made Manager of the St. Louis branch house of Park Brothers & Co., Limited.

Mr. W. C. Quincy has resigned his position as General Manager of the Pittsburgh & Lake Erie Railroad. He has had charge of that road since its first construction. Mr. Quincy has accepted a position with the large iron house of Jones & Laughlins, in Pittsburgh.

Mr. George S. Rice has been appointed Deputy Chief Engineer of the New Croton Aqueduct for New York City. He has been connected as Assistant Engineer with the waterworks of Lowell, Mass., and Boston, and was recently Principal Assistant Engineer of the new sewerage system of Boston.

M. Adolph Greiner has been chosen Director-General of the great works of the Société John Cockerill, at Seraing, Belgium, in place of Baron Sadoine, who retires. M. Greiner has been connectedwith these works ever since he graduated from

the School of Mines at Liège, and has been for several years head of the Steel Department.

Mr. Edward Nichols, who succeeds the late H. G. Brooks as President of the Brooks Locomotive Works, is an engineer by profession, having graduated from the Rensselaer Polytechnic Institute. He has for a number of years been connected with large iron and steel interests in Pennsylvania. He was recently President and Superintendent of the Ridge Valley Iron Company, of Georgia, and Vice-President of the Warren-Scharf Asphalt Paving Company of New York.

NOTES AND NEWS.

Narrow-Gauge Changes.—The Toledo Division of the Toledo, St. Louis & Kansas City Railroad has been changed from 3 ft. to standard gauge. The section changed is 206 miles long. The St. Louis Division of the road will be changed shortly.

The John Scott Medal.—The City of Philadelphia, on the recommendation of the Franklin Institute, according to custom, has awarded the John Scott Medal and premium to the Hall Steam Pump Company, of New York and Wilmington, Del., for its Duplex Steam Pump.

Philadelphia Elevated Railroads. — Two organized companies—the Consolidated Transit and the Philadelphia & Northeastern—are now applicants for rights to build elevated railroads in certain streets in Philadelphia. Both have offered to pay considerable sums for the concession.

Baltimore & Ohio Employes Relief Association.—The May report shows payments of $26,606 in benefits to 1,007 members of this Association. There were 4 deaths from accident and 14 from disease; 331 cases of accidental injury and 533 of sickness. In addition there were 125 physicians' bills paid.

Iron in Brazil.—Large deposits of magnetic iron ore have long been known to exist in Brazil, and several mines have been opened up in the Iquape District. Experiments have shown that iron of a very fine quality can be made from this ore. It is now proposed to establish iron works in connection with the mines.

German Rail Contracts.—The *Moniteur Industriel* (Brussels), asserts that the German railmakers have formed a pool or syndicate, the object of which is practically to exclude from all contracts in Germany the John Cockerill Works at Seraing, Belgium. These works have heretofore furnished large quantities of rails to Germany.

Brooklyn Elevated Railroads.—The new elevated railroad—the Kings County line—is now under construction at a rapid rate, the legal obstacles having been removed by a decision of the Court of Appeals. The foundations are completed for 4½ miles and the superstructure about a mile. Contracts for equipment have been let, and the road will probably be in operation by December next.

Oil Barges.—The Standard Oil Company has contracted with John Roach's Sons, Chester, Pa., for the construction of an iron barge for carrying oil in bulk in the coastwise trade. The barge will be 153 ft. long, and have 275,000 gallons capacity. She will be towed in the same manner that the coal barges are to the coastwise ports. If this barge proves a success further contracts will be given.

Bridging the British Channel.—M. Arnaudeau, in the *Revue Scientifique*, proposes a bridge from Dover to Calais, which shall carry a pneumatic tube large enough to transport the mails and small packages. His plan is to build towers some 400 ft. high above the water level and about half a mile apart, and to suspend the tube from these towers by wire cables. The towers are to be of such size that additional tubes can be added, if needed. The tubes can also carry telegraph and telephone wires.

High-Pressure Steam for Steam Jackets.—It is now recommended by some English engineers that the steam for the cylinder jackets of compound engines should be generated in a special boiler, and of a higher pressure than the steam used to drive the engine, and that as high a piston-speed should be obtained as can, with safety, be adopted—as in engines with a high piston-speed, everything else being taken into consideration, there was not the same initial and permanent condensation taking place in the cylinders.

Petroleum by Caravan.—A letter from Baku in the Transcaucasus, Russia, says that a new market has opened for the petroleum produced there. A company has been formed at Baku by several owners of camel caravans for the purpose of introducing petroleum into Persia by the overland route through Mughan. Several caravans have been sent, but they did not get beyond Mughan, because in each case the oil was all sold there. It is now intended to increase the caravans to 500 camels each, and it is expected that a considerable trade can be built up.

Prizes for Engineering Papers.—The Director General of Roads and Bridges in France, under authority from the Minister, has recently awarded prizes for papers written during the past year, as follows: Gold medal, 600 francs, to M. A. Considère, Chief Engineer, for his paper on the Use of Iron and Steel in Construction; gold medals, 200 francs, to M. R. Barabant, Chief Engineer, for his paper on Studies of Travel in London, and to M. A. E. Hetier, Chief Engineer, for his paper on Resistance of Materials in Sustaining Walls.

The Siberian Railroad.—It is stated that the Russian Government has resolved to push work on the Siberian Railroad, with a view to completing it within five years. This line is now completed to Ekaterinberg, and work is in progress from that point to Tiumen. The new plan is to begin work at once on the section from Tiumen to Tomsk, the capital of Western Siberia. From Tomsk the road will run to Irkutsk and thence to Stretinsk or Boorsa on the Amoor River, whence steamboats run down the river to Vladivostock, the Russian naval station on the Pacific.

Large Lake Vessel.—The new steel steamship *Oswego* was launched at Buffalo, July 7. She is owned by the Union Steamboat Company, and her dimensions are: Length over all, 357 ft.; between perpendiculars, 326 ft.; molded depth at lowest point, 25½ ft.; beam molded, 41 ft. She is expected so carry 2,800 tons of cargo on 15½ ft. draft of water. She has a double bottom 3 ft. deep, which can be filled with water, giving her about 800 tons of ballast. The *Oswego's* engines are of the triple-expansion pattern, with cylinders 28, 42½ and 72 in. in diameter and 54 in. stroke. There are six boilers, the working pressure on which will be 160 lbs.

Heavy Gun Lathes.—The two lathes built for turning and boring heavy guns are to be removed from the South Boston Iron Works to the Watervliet Arsenal at West Troy, N. Y. One of these lathes weighs 145 tons and the other 175 tons, and both can take in work 40 ft. long. With them is a crane built purposely to lift the guns and put them in position on the lathe. One of the great lathes was built at South Boston, the other at the Springfield Arsenal; both are the property of the Government. Several 10-in. and 12-in. guns have been turned on them.

At the Watervliet Arsenal preparations are in progress for the establishment of an extensive plant for making heavy guns for the army.

Steel Castings for Ships.—June 18, the Standard Steel Works, Thurlow, Pa., cast a steel stern-post for gunboat No. 1 and an engine bed-plate for the cruiser *Baltimore*, which vessels are being constructed at Cramp's yards, at Philadelphia. The stern-post, weighing 15,000 lbs., was cast without a defect.

The steel stern-post for the cruiser *Charleston* was successfully cast at San Francisco, June 22. The post is 22 ft. long on the keel, with an upright of 20 ft. and weighs upward of 15,000 lbs. It was claimed by the eastern competitors for the building of the cruisers that a post of the size necessary could not be cast on the Pacific Coast. The work was done by the Pacific Rolling Mill Company, which added to its extensive plant an open-hearth-steel department in 1884.

Iron and Steel Production. — The American Iron & Steel Association reports production for the first half of 1887 as follows, in net tons, the comparisons made being with the first half of 1886:

	1887.	1886.
Pig iron	3,417,903	2,954,209
Spiegeleisen and ferro-manganese	25,436	24,382
Bessemer steel ingots	1,637,572	1,073,663
Bessemer steel rails	1,154,193	707,447
Open-hearth steel ingots	1,74,400	92,540
Open-hearth steel rails		12,396

There was a falling off in bituminous pig, owing to scarcity of coke, but an increase in charcoal and anthracite iron. The stocks of pig-iron unsold June 30 was about the same as on January 1.

There are 31,043 tons of steel made by the Clapp-Griffiths process included in the Bessemer steel. Rails absorbed a very large part of the steel production for the half-year.

Cast-Steel Guns for the Navy.—On July 20 the Secretary of the Navy issued the following order:

"The Department has decided to postpone until September 20 the opening of proposals for the furnishing of steel cast guns for the Navy. This action is taken in order to give more

time to domestic manufacturers to consider the matter. The intention of Congress in making the appropriation was doubtless to enable experiment to be made with steel cast guns, and it will be the desire of the Department to meet liberally domestic manufacturers of steel who wish in good faith to submit to the department castings for the purpose in view. The act of Congress has fixed the test to which the finished gun must be subjected. It is the same test as that which the guns now being made by the Department safely stand. No gun finished by the Department has failed thus far upon that test. It is not deemed severe and is not supposed to represent at all the limit of extreme strength nor the capacity of the guns."

Railroad Axle Boxes with Paper Bearings.—Experiments are now being made on the Prussian State railroads with a passenger car fitted with Ulffer's axle boxes, in which the brasses are replaced by bearings made of segments of vegetable parchment, placed side by side and strongly compressed. The friction takes place between the body of the journal and the thin edge of the parchment segments, and according to the inventor the surface of his bearings is harder and in a better condition than that of any metal bearing. Care must be taken when building up the parchment bearings to have the material thoroughly dried, in order to prevent subsequent shrinkage, accompanied by buckling of the sheets. On the outside of these bearings are placed wooden rings, which fit the collars of the journal. These bearings may be lubricated either with an emulsion of water and oil, or with any of the usual mineral lubricating oils. The mass of the parchment becomes more or less impregnated with the lubricant, and thus the bearings may be left to run for comparatively long periods without renewing the lubrication. Some of these bearings have also been fitted in a saw mill at Ueckermünde, and have given perfect satisfaction.—*Industries.*

Triple-Expansion Engines.—The mail steamship, *Trojan*, built and engined by Messrs. J. & G. Thomson, of Clydebank, Glasgow, for the Union Steamship Company's Cape of Good Hope mail service, has had her engines converted from the compound to the tri-compound system by Messrs. T. Richardson & Sons, of Hartlepool, and has been supplied with new boilers working at a pressure of 160 lbs. per square inch. The diameters of the new cylinders are 34 in., 54 in. and 89 in., respectively, and the length of the stroke 60 in. The *Trojan* went out for her trial trip at Stokes Bay on May 28. She attained a mean speed of 13.9 knots per hour and indicated 4,092 H. P., her engines working at 66 revolutions per minute, with a steam pressure of 160 lbs. to the square inch. This shows an additional 530 indicated H. P., as compared with the *Trojan's* trial trip with the compound engines. The *Trojan* is the third of the Union Company's mail steamers which has been converted to the new system, and it is confidently anticipated that the result will be as satisfactory as in the case of the two others, the *Spartan* and the *Athenian*. The *Mexican* is now having her engines tripled, and will be followed, on her completion, by the *Moor*. The intercolonial steamers *Anglian* and *African* are also fitted with triple-expansion engines.

Drainage of Chicago.—The drainage of Chicago has always been difficult owing to its large area and to the fact that its site was originally a level prairie, only a few feet above the surface of Lake Michigan. It is therefore impossible to get fall sufficient for the drain, and as the lake is practically without tides or currents, and the water supply of Chicago is drawn from the lake, it is not a desirable receptacle for the sewage.

The Illinois River, which empties into the Mississippi, flows in a southwesterly direction, almost across the whole of the State of Illinois. A tributary—the Desplaines River—rises within a few miles of Chicago. This river is separated from Lake Michigan by a lime-stone ridge. Near Joliet, about 35 to 40 miles from Chicago, this river is 75 to 80 ft. lower than the extreme low-water level of the lake.

At a recent meeting of the Grant Club in Chicago, Mr. Gordon H. Nott read a paper in which he advocated the construction of a tunnel commencing in Chicago at about 40 ft. below the level of the lake and connecting with the Desplaines River, near Joliet. He proposes a system of precipitating basins, in which the solid portions of the sewage is to be collected.

The estimated cost is between nine and ten million dollars.

A New French War-ship.—A first-class ironclad, the *Marceau*, has just been launched at La Seyne-sur-Mer, near Toulon. The total length is 338 ft., with a width of 66 ft. and a depth of 43 ft. She draws 26 ft. of water and has a total displacement of 10,582 tons. The spur placed in her bow is of bronze and is 10 ft. long. The hull is all made of steel except the keel, which is iron. She has three full decks, and is divided into 15 transversal, water-tight compartments internally. The weight of the hull is 3,875 tons, and the plates on the ironclad deck are 4 in. thick, and they extend the full length of the vessel. The engines, boilers, powder magazines, and the apparatus to be used for manœuvring the heavy artillery, will be well protected, the weight of the plates on the sides of the vessel, the deck, and the turrets exceeding 3,000 tons. The weight of the engines is about 626 tons, and that of the boilers about 341 tons. The trial speed of the *Marceau* is fixed at 18 knots an hour. She is to be armed with four 14-in. guns placed in four barbette turrets, which are placed in the longitudinal axis of the vessel, one forward and another astern, with two others in the lateral axis. The small artillery will include seventeen 6-in. guns in the battery, while revolving and rapid-firing guns will be placed in various parts of the vessel. There will also be four torpedo tubes.—*Engineering.*

Russian Steamboats on the Volga.—The Russian steamboat service on the River Volga, which has been largely developed and much improved of late years, has been increased during the last few weeks by two more steamers of the American type, purchased for $105,000 each by the Samolet Company. These vessels, called respectively the *Pushkin* and *Lermontoff*, are 254 ft. long and 50 ft. broad, provided with engines of 180 normal or 800 indicated horse-power, steaming at 18 miles an hour. Each will carry 1,500 passengers and about 130 tons of cargo. American type steamers are very popular in the Volga and are used by most of the large companies, the Kavkaz & Mercury Company, which carries the mails on the Caspian, having no less than 11 of them. One of its vessels, the *Suvoroff*, is 286 ft. long, 35 ft. broad, and has engines of 1,500 I. H. P. During the great fair at Nijni Novgorod, it carries 2,000 passengers each trip, besides 500 tons of cargo. The Zeveke Company has five vessels 280 ft. long and 40 ft. broad, with engines of 1,000 I. H. P., which carry a still larger number of passengers. Latterly, the same company has built five stern-wheelers. Great breadth of beam and plenty of saloon accomodation are the favorite features of these vessels, which have to run long trips of five to seven days duration up or down are Volga, between Nijni Novgorod, and Astrachan, and the rarely exposed to rough weather, for which their light construction hardly fits them.

Blast Furnaces of the United States. — The *American Manufacturer*, of Pittsburgh, says: "In a condensed form, the statistics of the furnaces for July 1, are as follows:

	In blast.		Out of blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	77	13,969	101	10,578
Anthracite	136	37,662	66	16,624
Bituminous	101	53,355	112	59,014
Total	314	104,986	279	86,216

"As compared with last month there is but little change in the totals, 314 furnaces being in blast July 1, as compared with 311 June 1; the total weekly capacity of the furnaces in blast June 1 being 107,964 tons, and of those in blast July 1, 104,986, the explanation of the greater capacity with less furnaces in blast June 1 being that a larger proportion of charcoal furnaces are in blast July 1 and a less number of coke.

"As compared with a year ago, the number of the furnaces in blast is as follows:

	July 1, 1887.		July 1, 1886.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	77	13,969	59	10,420
Anthracite	136	37,662	119	33,225
Bituminous	101	53,355	132	28,005
Total	314	104,986	310	71,650

"Some of the changes, especially in the bituminous furnaces, are due to special causes, such as the strike in the coke regions of Pennsylvania."

Aluminium and Wrought-Iron.—Recently we had occasion to refer to some successful experiments in the manufacture of cast-steel, free from blow-holes. The results were due to the admixture to the steel of 0.1 per cent. of aluminium. During the week just closed, experiments were made with puddled iron in charges of 500 lbs. The results were by no means conclusive, but enough was shown to illustrate the advantages of combining aluminium with iron. Strangely enough, the charges containing the low percentages of alloy turned out the strongest material. So, for instance, the addition of 0.1 per cent. aluminium raised the tensile strength from 52,000 lbs. to 60,000 lbs., an increase of 16 per cent., while the elongation was variously increased up to 21 per cent. One of the tests conformed to the method of testing marine steel, the elongation of the 1-in. test-spot being 0.1875 per cent. or $\frac{3}{16}$ in.

What may be done with puddled iron is shown by experiments conducted by Mr. Graham W. Thompson, a leading iron manufacturer of Glasgow. The tensile strength of ordinary puddled iron, 22 long tons with 12 per cent. elongation, was, by the addition of 0.25 per cent. of aluminium, increased to 31 long tons with 23 per cent. elongation. When mixed in equal parts with ordinary stock, this treated material still showed a tensile strength of 28 English tons, with 8.28 per cent. elongation; and a third mixture of the already reduced stock with common stock resulted in a tensile strength of 25 tons, with 7 per cent. elongation. The experiments with puddled iron will be pursued in other ways until some fixed rule of procedure may be established.—*Cleveland Iron Trade Review.*

Grade Crossings in Massachusetts.—The report of the Massachusetts Railroad Commission for 1886 says:

"The number of crossings of railroads and highways at grade, according to the returns, is 2,138, of which 738 are protected by gates or flagmen.

"Seventeen grade crossings have been allowed during the year. Only one of them was an important one, and it was permitted because by such action the abolition of two like crossings was secured. Some of the others merely took the place of crossings now existing, some were crossings over streets that only exist on paper, and a few were granted because they were absolutely necessary.

"The Act of 1885, chap. 197, designed to promote the abolition of grade crossings, has proved useful, especially on the Old Colony Railroad, where 10 level crossings have been abolished. It is to be hoped that other companies will follow the good example set by this company in expending time and money to rid the public of the dangers arising from this cause.

"If legislation is needed to facilitate the reduction of the perils arising from this source, we believe that the General Court is ready to act. We repeat our suggestion, that a railroad company resisting the creation of a new grade-crossing is not to be regarded as a public enemy; acting only from selfish motives, And we renew the proposition, that where a new highway is laid across a railroad, some tribunal may be empowered in fit cases to apportion among the proper parties the expense caused by the construction of a bridge, notwithstanding the fact that the railroad is the 'first comer.' Such an act would check the demand for grade-crossings, relieve towns from apparent hardship, and remove a source of great discontent."

Electric Street Railroads.—The New Brunswick City Railroad Company, at New Brunswick, N. J., has applied to the City Council for permission to use electric motors of the Van Depoele system on its cars.

The officers of the Belt Line, in New York City, nearly all of whose cars and horses were recently destroyed by fire, are considering the question of adopting some electric motor on their road.

A car operated by an electric motor actuated by storage batteries on the Julien system has been making experimental trips on the Fourth Avenue line in New York City. These trips were very successful.

Work is now in progress on a cross-town line running from Fulton Ferry to Chambers Street Ferry in New York. This line is to be operated by electric motors on the Bentley-Knight system, the electric current being carried through an underground conduit, connection being made by a contact-plow carried on the car or motor.

An experimental car is now at work in Philadelphia which is propelled by an electric motor deriving its power from storage batteries of the system used by the Electrical Accumulator Company, of New York.

It is proposed to use electric motors on some of the street-car lines in New Orleans, but no decision has yet been reached as to the kind of motor to be used.

The Union Passenger Railroad Company in Richmond, Va., is laying some 13 miles of track, on which electric motors will be used. The power will be taken from two overhead wires carried on poles, and the cars will be equipped with the Sprague motor. In cold weather the cars are to be heated by an electric apparatus invented by Dr. W. Leigh Burton, of Richmond.

Basic Slag as a Fertilizer.—The Birmingham correspondent of the *Engineer* writes that a machine plant has just been erected at the works of the Staffordshire Steel & Ingot Iron Company for the reduction to a fine powder of basic slag for fertilising purposes. This is practically a new industry, not only for the district but for England, since, although slag is being exported in large quantities from the works of the Northeastern Steel Company, Middlesbrough, for this purpose, the product is exported almost wholly to Germany, where, by special plant, it is reduced to an exceeding fineness, sufficient for agricultural purposes, and is exported back again to this country, where it is commanding a price of 30*s.* per ton, delivered in the Thames, and is having a large sale.

The plant has been supplied by Messrs. Morris Brothers, engineers, of Doncaster, and is very similar to that employed in grinding super-phosphates. It consists of one preparing mill fitted with Wood's patent separator; one magnetic separator; and one Morris & Wood's patent fine mill. The whole is driven by a powerful compound engine by Robey & Co., of Lincoln, of about 30 nominal H. P., or 80 actual H. P. The process of pulverizing the slag is divided into three stages—first, the slag is fed into the preparing mill in its rough state, and is reduced to about $\frac{1}{16}$ in., and any pieces of steel exceeding that dimension, accumulating in this mill, are taken out at intervals. During this preliminary reduction a quantity of fine slag is produced, and is extracted by the separator before the reduced material passes to the second stage, during which a magnetic separator extracts the small pieces of steel. The reduction of the material at the last stage enables it to pass through a mesh of 10,000 holes to the square inch—an obvious advantage, since the value of the material greatly depends upon its fineness.

An extensive plant for similar purposes is also, I understand, being erected at the Northeastern Steel Works, who intend to supply the ground material to home agriculturists, instead of allowing the Germans to do the trade.

The East Boston Electric Freight Railroad.—The ease and slight expense at which an electric railroad can be operated in large works already provided with a dynamo for electric lighting is well shown in the venture recently carried out by the East Boston Sugar Refinery at East Boston. This refinery, which is the largest in New England, is situated about 1,300 ft. from the docks where the raw sugar is unloaded from the ships. Formerly the hogsheads and bags were loaded on a railroad truck drawn by horses, the work being such as to tax the animals very severely and necessitating frequent changes.

As the refinery is provided with a 150-light Edison plant, it was determined to put in an electric railroad, and the installation was undertaken by the Sprague Electric Railway Motor Company of New York.

The rolling stock consists of two flat cars, one of which carries the motor of 15 H. P. at its forward end, together with a raised platform, upon which are placed the regulating and reversing switches. The cars are capable of taking a load of 12 hogsheads, equivalent to 30,000 lbs. The current is taken from the lighting dynamo and led to the motor from an overhead wire and trolley, the track being used on the return.

With the electric railroad the work of transferring can be done in one-fourth the time formerly required with horses; and although ships are constantly unloading at the docks the limiting capacity of the railroad to handle the work has not yet been reached.

The motor operates without noise, and although the track is always in bad condition, being invariably covered with sugar and molasses, no difficulty in operation has yet been experienced. Another interesting feature is the fact that thus far no appreciable increase in coal consumption due to the operation of the electric railroad in connection with the lights has been noticed.—*Electrical World.*

The Transcaspian Railroad.—The Russian *Official Messenger*, speaking of the works on the Transcaspian line, says: "In 1886, the Transcaspian Railroad line commenced upon the eastern shore of Gulf Mikhailovsky, at the station of Mikhailovskoe-Turkmenskoe. The shallowness of this gulf made it accessible only to vessels with a very small draught of water, and the sinuosities of a canal 40 versts long, marked out by a double row of stakes, was a serious obstacle to navigation. As a rule, the passengers were obliged to get out of the train at Krasnovodsk and get on board a small vessel, which could only travel by daylight, all this causing a great loss of time and considerable expense. In order to facilitate communications with the Transcaspian Province, it therefore became necessary to prolong the railway line to a point along the coast which could be reached by vessels with a deep draught of water. The Bay of Krasnovodsk answered these requirements, but the road leading to it was some distance from Mikhailovskoe, and very hilly, so that a railway in this direction would have been very dear. The result of an exploration made by the order of General Annenkoff went to show that in the vicinity of the island of Uzun-Ada, upon the route leading to the Bay of Mikhailovsky, there was a bay which, with a very slight outlay for dredging, would answer all purposes. The work was soon effected, and a small town named Uzun-Ada has already been built upon

the southern coast of the Dardja Peninsula. This has already proved of considerable service, in that it has enabled the engineers to receive from Astrachan, without break of bulk, all the materials required for the construction of the Amu-Daria line. As the canal leading to Uzun-Ada is very narrow and sinuous, it has been marked out with a double row of posts, to which are attached lanterns lighted with photogene. The whole Transcaspian line, from the station of Uzun-Ada to the Amu-Daria, has a total length of 1,011 versts, of which 794 were constructed in a little more than a year. All the materials were brought down the Volga from Astrachan. At present the regular trains run upon the new line twice a week."

Russian and English Government Engineering.—The London *Engineering* says: "The departure of General Annenkoff to supervise the construction of the railway from the Oxus to Samarcand and Tashkent, contrasts forcibly with the news from India that the Indian Government is only now beginning to think of surveying the country for twelve miles ahead of Peshawur, in the direction of Cabul. It is a well-known fact in military circles that the plans of the Indian Government for the defense of India against Russia, provide, among other things, for the immediate construction of a railway to Cabul, the moment Russia attempts the invasion of Afghanistan. On the first intimation of war, troops would at once march to Cabul to help the Ameer, and the Peshawur Railway would follow as swiftly as possible through the Khyber Pass to help them. Such being the plan that has existed on paper since the last war scare two years ago, one would have naturally thought that the Indian authorities would have long ago surveyed the country for the line, and prepared the working drawings for its rapid construction. Instead of which, it is only now that the government is concerning itself about the survey, and thinks its efforts equal to the occasion when it confines the survey to twelve miles, or a single march, out of the total distance between Peshawur and Cabul. Considering that our relations with the Ameer are of a most amicable character, that we pay him 10,000*l.* a month, and there is a regular stream of safe traffic constantly between Peshawur and Cabul, it ought not to have been impossible to have obtained a survey long ago—even a rough one, taken by engineers in disguise, would have been better than none at all. Neither the government in India nor the authorities at home appear to realize that Russia's engineering activity in Central Asia will tell more on the fortunes of the next campaign than any other conceivable factor. While we are content to defend India by ordering the survey—only the survey—of twelve miles of frontier line, Russia, in spite of her financial difficulties, is boldly commencing the construction of 500 miles more, to add to the 700 already constructed from the Caspian to the Oxus, and makes no secret that the railway is intended purely for purposes inimical to our rule in India."

The Iron-Worm.—The London *Ironmonger* gives the somewhat alarming statement, "from a German source," that the existence has just been discovered of a detestable microbe, which feeds upon iron with as much gluttony as the phylloxera upon the vine. Some time ago the greatest consternation existed among the engineers employed on the railroad at and near Hagen by the frequency of accidents occurring at a certain point, which seemed to prove that some serious defect must exist either in the material or construction of the rails. The German Government ordered that a strict inquiry be made, and a commission of surveillance be formed for the purpose of keeping close watch at the spot where the accidents had taken place. It was not, however, until six months had elapsed that the discovery was made. One of the trackmen had observed that the surface of the rails seemed to be corroded, as if by some acid, for a distance of about 280 ft. The rails were taken up and were found to be in very bad condition, several of them breaking into three or four pieces when the men tried to lift them. When these rails were carefully examined, it was found that they were literally hollowed out by a thin gray worm, to which the qualification of "Railoverous" was assigned; by this name it will be known in natural history. This worm is from 6 to 9 millimeters in diameter, and from 20 to 25 millimeters in length. It is of a light gray color, and has on its head two glands filled with a corrosive secretion, which it ejects at intervals of 5 or 10 minutes, and which has the effect of making the iron soft, spongy and of a light red color. It is then devoured greedily by the insect, which seems to have an insatiable appetite. These worms, it is stated, destroyed no less than 36 kilogrammes of rails in a few days; how many of them it took to do this is not stated. Further careful investigations into the origin, habits, etc., of this terrible worm are to be made.

We should prefer to see a few specimens of the "railoverous worm" before taking active measures to prevent its importation into this country. It is, perhaps, some relative of the "ice-bug," which is occasionally reported to be destroying the ice crop in this country, but of which the German entomologists do not seem to have heard.

The Naval War College.—The Naval War College will reassemble at Newport on the first Monday in September, and continue in session until late in December.

Commander Bainbridge-Hoff will give a digest of contemporary foreign opinions on the subject of naval tactics, both of single ships and of fleets. The tactics of the gun, of the ram, and of the torpedo, their best and most effective method of use, that is, in actual battle between opponents, or between contending fleets, will be separately treated, each by an officer who will aim at bringing out the strength of his weapon and the weaknesses of the other two. These will be followed by some lectures on grand tactics. The question of naval gunnery will be treated by Lieutenant John F. Meigs, whose lectures last year were particularly interesting and instructive. Professor Soley will give his lectures on international law. The subject of coast defenses will be discussed, as last year, by an army and a navy officer. General Abbot, of the Army, will aim at giving naval officers an insight and grasp of the general principles which guide the military engineer in planning and constructing the defenses of harbors. The question of sea-coast defenses will be exhaustively discussed from the naval point of view by Lieutenant C. G. Calkins, of the Naval Intelligence Office. The subjects of military strategy and tactics and of naval history will be treated by the same officers as last year. Assistant Naval Constructor Gatewood will lecture on the preservation and care of iron ships, and upon the injuries to which they are liable from grounding, collision, etc. Medical Director Dean will lecture on Naval Hygiene.

Lieutenant-Commander Stockton is now engaged upon an examination of the way in which the various nations of Europe are stationed in the Gulf of Mexico, the Caribbean and in the Pacific Ocean, with a view to determining the relative strategic value of these stations. It is intended that the study of the Gulf and Caribbean Sea, regarded as a great strategic field of special importance to the United States from its proximity, and above all, if any trans-isthmian canal shall be made, shall form a prominent part of the War College course. Mr. Stockton will bring together the facts of commerce and existing trade routes between the Western Pacific (Australia, China, etc.) and Europe; together with the modifications likely to follow upon the building of a canal.—*Army and Navy Register.*

New Consolidation Locomotives.—The Pennsylvania Company has recently completed, at its shops in Fort Wayne, Ind., some consolidation engines of a pattern known as Class S, These engines have cylinders 20 x 24 in. and four pairs of 50-in. drivers. The spread of the cylinders is 7 ft. and the total wheel-base of the engine is 21 ft. 6 in. The total weight of the engine in working order is 105,500 lbs., divided as follows: On truck, 11,250; first pair of drivers, 23,700; second pair of drivers, 21,750; third pair of drivers, 23,450; fourth pair of drivers, 25,300 lbs.

The boiler is of the straight-top pattern, with one dome; the barrel is 58½ in. diameter, and there are 157 tubes 13 ft. 3⅜ in. long. The fire-box is 7 ft. 11¾ in. long and 34⅜ in. wide inside. The grate area is 22.6 square feet, and the heating surface 1,361 square feet. The working pressure is 125 lbs. Crown-bars and bolts are used to support the crown-sheet, instead of long staybolts to the outside crown-sheet, this change having been made to facilitate the cleaning of the crown-sheet, which has to be done frequently on account of the impure water on the line.

These engines are equiped with the Westinghouse driver-brake and the Ross steel brake-shoe. U. S. metallic packing is used on piston rods and valve rods.

Two sizes of tenders are used with these engines. The first has a tank holding 3,000 gallons of water and 9,200 lbs. coal, and weighs 22,500 lbs. empty and 56,650 lbs. loaded. The larger tender carries 3,600 gallons of water and weighs 30,600 lbs. empty and 60,650 lbs. loaded.

These engines were designed to run freight trains which have heretofore been run by "double-headers"—that is, two locomotives coupled, each having 16 x 24 in. cylinders and 62-in. drivers. The Class S engines handle the same train as the two light engines with ease, and with a considerable saving in fuel and other expenses.

Recently comparative trial trips have been made over the Pittsburgh, Fort Wayne & Chicago road, between Fort Wayne and Chicago, by one of the Class S engines and the Strong locomotive *Duplex*, to test their relative economy in the consumption of fuel. The Strong engine has also been run on passenger trips on the same line. The result of these tests has not heen announced.